UNIT TRAINING COSTS AS A PART OF LIFE CYCLE COST: A METHODOLOGY.

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THESIS

UNIT TRAINING COSTS AS A PART OF
LIFE CYCLE COST: A METHODOLOGY

by

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This paper examines the unit training costs, defined herein as company and battalion level training, associated with the introduction of a new weapon system into the Army inventory. The Army Life Cycle Cost Model does not address unit training costs, and accordingly there is a significant cost during the acquisition process that is not recognized. Recommendations are included for a means to arrive at life cycle cost figures

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Unit Training Costs as a Part of Life Cycle Cost: A Methodology

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ABSTRACT

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I. INTRODUCTION

A. NATURE OF THE PROBLEM

With technological advancements in warfare, and in the weapons designed for that warfare, increased emphasis has been placed on cost-effectiveness analysis in an effort to procure the most effective and efficient hardware available. Such efforts entail analysis of complex interrelationships among man, machine, and organization. Conceptually, one-half of the cost-effectiveness analysis consists of arriving at a life cycle cost for a proposed system. "Life Cycle Costing" has been a recognized term in the defense industry since the early 1960's. As a formal concept, it was initiated by the Assistant Secretary of Defense for Installations and Logistics.[1]

Life cycle costs play the following roles in defense management. During a system's definition phase, life cycle cost estimates are parametric cost equations used to estimate the system's ultimate cost; and during a system's development phase, life cycle cost estimates are used to identify the minimum cost system. Life cycle costs are an attempt to describe all costs of acquisition and ownership incurred over a specified period of time, typically ten years. As such, it decomposes total costs by such broad categories as development, production, operation and support. Mathematical equations, whose arguments include

a system's performance or descriptive parameters, are used to predict the variation in cost of each of the components of a weapon system.

Among the more difficult costs to estimate are those involving training. The life cycle cost model currently used by the Army is described in DA Pamphlets 11-2,-3, and -4. It addresses individual training in considerable depth. Allowances are made for initial, replacement, and recurring training for skills needed to man a particular weapon system.

As will be shown, the life cycle cost model currently in use does not address the costs associated with unit training generated by the introduction of a new weapon system. Unit training as discussed in this paper refers to that training conducted by company and battalion level units belonging to operational commands. The basic purpose of this paper is to identify the costs that a unit incurs because it is issued a new weapon system. The authors do not believe sufficient attention has been given to the unit training aspect in the cost estimation process. The costs in question which have been termed "transition costs" by the authors, include recurring and non-recurring training costs. They will vary greatly with the type of weapon system being considered. Such parameters as the number of systems per unit, crew members per system, and complexity of operation and employment will all impact heavily on the

magnitude of unit training cost involved. Thus, a decision concerns which of several proposed systems should be procured, and the life cycle costs of each system are a key element in that decision. The decision-maker should have the more complete life cycle cost estimate including unit training costs.

One cannot correctly define or determine training costs, however, without considering the output, or effectiveness, of the training. That is, a given level of training may be found to cost $x; the problem then becomes one of determining whether that given training level achieves a desired level of effectiveness. Analysts are then faced with determining the marginal effect that additional dollars invested in training will produce. During the development phase of the acquisition process such determinations are largely subjective. However, through discussions with individuals who will be employing the new system, by analysis of historical data concerning similar weapons, and by testing of prototypes, reasonable estimates of training effectiveness can be made.

Once effectiveness has been estimated, the problem becomes one of determining the costs of a unit achieving that level of effectiveness. There is a degradation of readiness that occurs initially upon receipt of a new weapon system. The magnitude of this degradation will

vary with the weapon system and the extent to which externalities impact on the unit. The availability of trained personnel in the unit at the time the weapon system is received acts to reduce the training time required to return to the previous level of combat effectiveness. However, some period of time is required, even with trained personnel, for the unit to become proficient with the tactical employment of the new system. During this time, costs are incurred in returning the unit to its previous level of readiness. It is those costs upon which this paper will focus. A graphic portrayal of this major premise is shown at Figure 1.

B. APPROACH TO THE PROBLEM

In attempting to derive a system for including unit training costs in a life cycle cost model, one must first examine the cost model currently in use. This examination includes a description of the pertinent parts of the model; that is, it examines those portions in which unit training costs would most logically fall. An understanding of what the current model does and does not include is essential in considering the problem.

An analysis of training costs inevitably leads to a notion of training effectiveness. The authors will survey the current developments in training techniques that are being employed by today's Army. The techniques include an

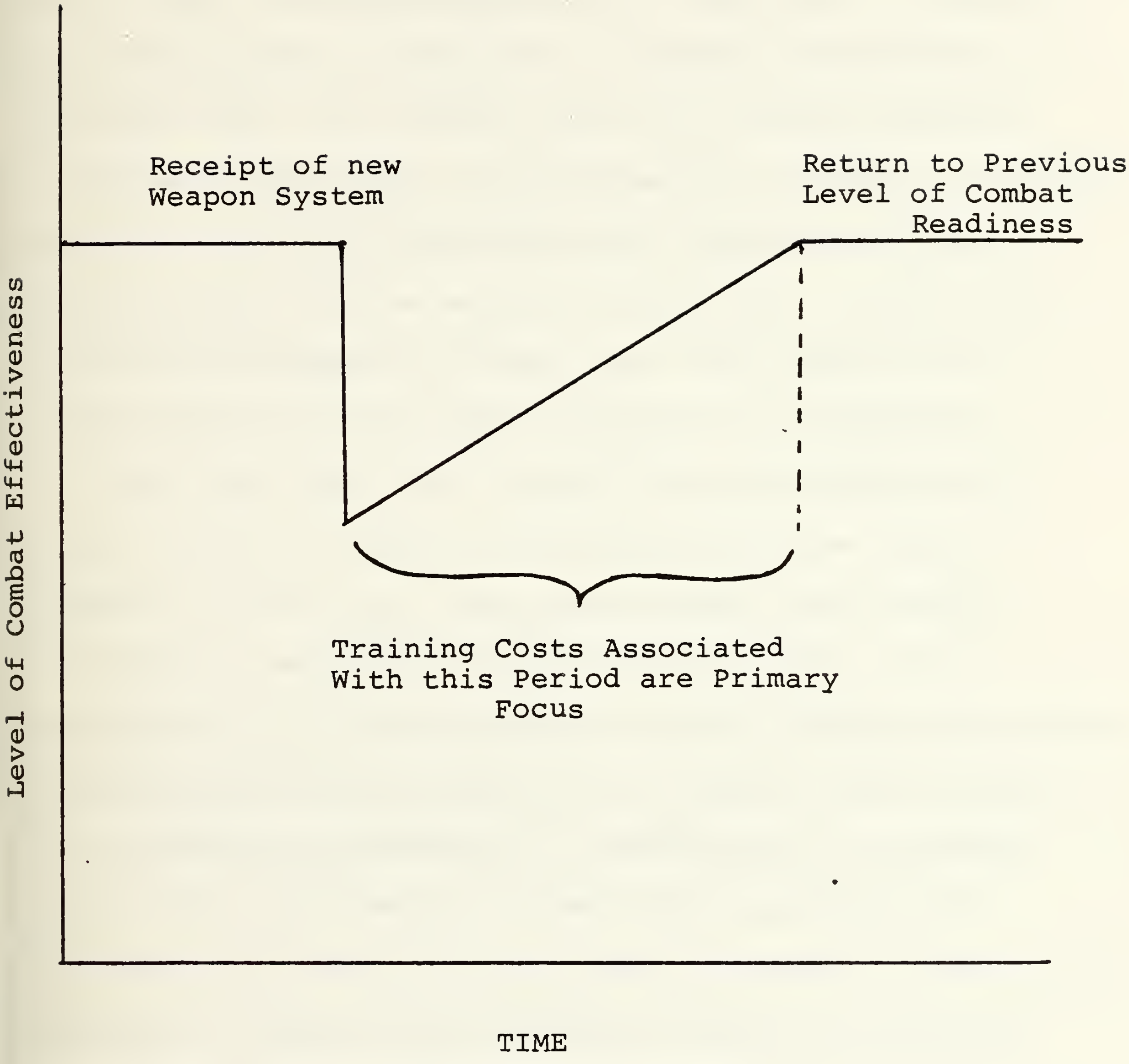
Receipt of new
Weapon System
Return to Previous
Level of Combat
Readiness
Level of Combat Effectiveness
Training Costs Associated
With this Period are Primary
Focus
TIME

Figure 1

array of methods that permit varying degrees of force on force engagements in field environments, as well as computer and computer assisted training systems. The framework in which these training techniques are employed is important in understanding the methods of training effectiveness analyses used. The various types of training analyses conducted by the Army are discussed in an effort to provide an understanding of the timing and importance of such considerations in the acquisition process. An overview of current developments in these areas will assist in an understanding of the costs involved in unit training.

This paper will next examine the cost components of unit training including an explanation of the costs that are relevant for the problem under consideration. The Training Management Control System (TMCS) will be explained, for it ties directly into the training parameters described and may hold the key to a better unit training cost estimating methodology. A methodology is proposed, using data collected by the TMCS, for estimating unit training costs induced by new weapon systems. No additional hardware or massive data collection effort is required to implement the methodology presented.

One may ask why it is important to estimate the unit training cost, in that it would appear to be an insignificant percentage of the operating and support costs.

However, it is not possible to substantiate that appearance, in that no relevant data is formally collected by the Army. Therefore it is important to estimate unit training costs separately.

In attempting to isolate an example of transition costs associated with the introduction of a new weapon system, the authors have chosen the Army's heavy anti-tank weapon, the TOW. The TOW is currently the major operational weapon system for enabling the infantry to survive in an armor-threat environment. It is a simple weapon system to operate, however, its introduction has caused major changes in infantry doctrine, which requires greater emphasis on unit training in becoming proficient in its employment. This shift in emphasis from individual to unit training warrents an analysis of costs incurred.

The 7th Infantry Division, located at Ft. Ord, California was receiving the TOW during the research for this paper, and was therefore selected as a case to study. It is significant to note that the transition costs studied represent at least 1.3% of the entire Operations and Maintenance budget for the 7th Division in FY 77.

How a system's transition costs can be expected to vary with parametric changes in the weapon system's performance characteristics is beyond the scope of this paper. This thesis has only the limited objective of delineating a

method for estimating the magnitude of a system's transition costs.

II. LIFE CYCLE COSTS

A. INTRODUCTION

This chapter addresses the concept of Life Cycle Costs (LCC) and discusses what part they play in the cost analysis of weapon systems as well as how they come into play in the problem addressed by this paper.

The term life cycle cost is generally defined as follows: "Life Cycle costs include all anticipated expenditures directly or indirectly associated with an alternative."[2] Another way of looking at life cycle costs is given by the Joint Tactical Communications Office.[3] "... the costs that reflect the total resources required and consumed during the complete life cycle..." and "In general, these kinds of costs include total cost of acquisition and ownership of the equipment over its full economic life."

In the context of this paper then life cycle costs are to be understood as the total cost to the government of the acquisition and ownership of a particular weapon system. "Costs" are usually defined by either a measure of the resources consumed or of the alternatives foregone. The reader should not confuse these references to cost

as "accounting" costs, which are records of money expended for resources. There are, at least conceptually, more satisfactory ways to measure costs.

Fisher[4] states that there are four ways to measure costs; by the resources required, by the alternative uses of the resources, by the value of the alternatives, or by the dollar expenditures to acquire the resources. The life cycle cost approach looks at the measurement of costs in dollars usually, since the choice situation is assumed to have a distant time horizon. The cost measurement by the highest valued foregone alternative opportunity can also be used when comparing system effectiveness. However, the dollar cost measurement remains the most popular.

The Army force structure is created incrementally. That is, changes in the force structure are the result of decisions to introduce new weapon systems or alter the table of organization of relatively small units. Technical changes are introduced through a variety of new weapon systems that are adopted and gradually phased in to the inventory. Many of these technical changes are embodied in the weapon systems as the result of loosely coordinated decisions on adoption of the new system. Often many of the changes induced by a new system are not recognized until after the weapon system has been in the hands of units for some period of time.

The officially recognized decision methodology used in weapon system acquisition is the LCC and a localized measure of effectiveness. This methodology requires that two assumptions be made: (1) It assumes that the measure of effectiveness used is measurable in a globally consistent manner. That is, the effectiveness of the weapon system in a European, high intensity environment is measurable in the same manner as the same weapon system employed in a Southeast Asian, low intensity environment. This assumption is not germaine to this paper and will not be pursued.
(2) The use of LCC assumes that the decision concerning acquisition of the weapon system is to be made by evaluating total LCC and choosing the system from among those providing a given level of effectiveness that has the lowest LCC cost. The validity of this assumption rests on a presumption of the acceptability of a temporal transfer of the budget between years without regard to the amount to be spent in any one year. Further, it is presumed that the probability of war is so low, or so far in the future, that the decision can focus on only peacetime costs.

While the LCC concept is sound, its implementation is extremely difficult. The concept is based on the assumption that procurement decisions will be made in terms of the lowest LCC consistent with effectiveness. In practice, decisions are alleged to be made in terms of the minimum

procurement cost, with little or no consideration being given to operating and support costs that are not going to be encountered until many years hence. Realistically, project managers have very little organizationally provided incentive to minimize operating and support costs when the decision variable is the minimum procurement cost.

Additionally, the Army's force structure is managed by units and not by weapon system. This means that identification of a particular weapon system's operating and support costs is extremely difficult, and perhaps impossible, to accurately determine. The absence of readily retrievable data for operating and support costs leads the decision maker to focus on procurement costs alone.

Implementation of the LCC concept is also obstructed by a failure to explicitly recognize that the effect of a weapon system's introduction on a force unit's total effectiveness should be charged to the LCC of that weapon system. That is, a cost element is required in the LCC model that accounts for additional training requirements generated by the new system. The absence of such a cost element is indicative of the grave difficulties encountered in implementing what is an overly simple conceptual depiction of the functioning of the military's economy. Further complexities are introduced if one considers

introduction of two or more weapons systems simultaneously with synergistic effects on training requirements due to interdependence between the systems.

"Inasmuch as new material or systems often affect concepts of operation and organization, the total costs of material systems must include costs such as those resulting from changes in unit training, firing practice, and theater stockage, as well as the costs which are directly associated with the acquisition of the material system."[5] That is, life cycle costs must recognize the differential of resources consumed due to change in operational procedures.

B. LIFE CYCLE COST COMPONENTS

To provide further insight into what life cycle costs are and how they reflect the total cost of a system, an examination of the components of life cycle costs follows:[6]

<u>Development Costs</u> - Those expenditures associated with developing the technological know-how to produce the new capability. Usually this cost is not a function of how many systems are bought nor of the time needed to develop the capability only.

<u>Investment Costs</u> - Outlays which are involved with producing the needed equipment and setting up the new program. These costs are a function of the magnitude of the program as well as a function of the production rates and schedules.

They are not considered to be a function of the time of operational use by the force. That is, they may be considered a one-time cost of introducing a capability into the operational inventory.

<u>Operating and Support Costs</u> - These are all the additional costs of using the new capability or keeping it operationally ready. These will be recurring costs required year by year to operate and maintain equipment or weapon systems over a period of years. Hence these costs are a function of both the size (numbers) of the capability acquired and the length of time for which it is to be operational.

By developing and estimating the total costs of a weapon system over its projected economic or operational life, it is then possible to develop relationships between selected characteristics of such a weapon system and the costs which are a direct result of that characteristic. In deriving a cost estimating relationship, the degree of decomposition of LCC is dictated by the ease of minimizing the variance of the estimate. That is, very little decomposition would be expected in arriving at an LCC by means of a parametric estimate. Conversely, for effective management of a weapon system greater disaggregation of the LCC would contribute to increased accuracy in budget preparation.

C. ESTIMATING METHODS

Two methods of estimating costs, industrial engineering and parametric, are usually distinguished. The industrial engineering consists of a "bottom-up" approach, that is a consolidation of estimates from various separate components or work segments into a total aggregation. This approach is most useful when the system under consideration has already been produced or greater accuracy is desired.

When there is a requirement for a grossly accurate cost estimate and no similar system has ever been produced upon which to base an industrial engineering cost estimate, a parametric estimate is developed. This method depends upon sufficient historical cost and performance data being available to allow cost estimation relationships to be developed using that performance characteristic as a cost parameter. For example, through the use of simple linear regression analysis the cost of a new type of airplane could be estimated as a function of its airspeed (presumably greater than any airplane now existing) or its weight (again greater than any existing), or both variables.

The problem that must be dealt with in using parametric cost estimates is the possibility that structural inaccuracies may occur in their development. It must be remembered that this method is used because there is no current or prior system upon which the industrial engineering estimate can

be developed. This can also be taken to mean that the proposed system is distinctly different than the current system and not just a technological development. Because the desired information extends beyond the limits of existing data (known as the relevant range to statisticians) it is inherently subject to wider confidence levels (is more inaccurate). The inaccuracy of this method is offset primarily by the ease of development. While accuracy can be improved over the course of time, this requires further committment of resources which may not be appropriate in the conceptual stages of a weapon system's development. Therefore the parametric cost estimate is a trade-off of accuracy for timeliness.

This estimating method is especially appropriate for the TOW missile training since the biggest change introduced was the tremendous increase in the range at which an infantryman could disable or destroy a tank. With the old system, the 106mm recoilless rifle, a tank could only be engaged at a maximum of 1100 meters. With the TOW the maximum killing range is extended to 3000 meters.

From a systems analysis viewpoint, the LCC of TOW is comparable to the LCC of the collection of weapon systems which can provide an equivalent effectiveness. From a system insertion viewpoint, the relevant LCC of TOW are the cost components corresponding to the disaggregation of

management actions required in the introduction and peacetime operation of the weapon system. One of the significant LCC components in this regard is training costs.

D. THE RELATIONSHIP OF LCC TO TRANSITION COSTS

As stated in the introduction to this paper, a degradation of unit readiness occurs upon introduction of a new weapon system into that unit. Because the life cycle cost concept is intended to transmit the entirety of costs to the decision maker, the authors believe that the cost of regaining the required level of readiness should be addressed by the life cycle cost model. There are three characteristics of this effect which are described as follows: (1) The unit sustains a reduced readiness capability of an appreciable magnitude, the exact amount depending on the extent to which the weapon system directly or indirectly contributes to the unit's operational capability or mission. The degradation of readiness is also a function of the method used to integrate the weapon system, that is, whether the replaced system is immediately evacuated from the unit or whether the new system is used as a parallel system until training is completed. In either case there will be a degradation, but the magnitude may differ. Other aspects of this reduction in readiness is the qualification of operators and/or crews and the ability of the unit commander to employ the system in a tactically

sound fashion. (2) After a unit overcomes the first characteristic, there remains the recurring requirement for periodic update training or refresher training within the unit. This requirement falls under the function of unit training and may require crew or operator requalification on a periodic basis and may also require periodic unit deployment under training evaluation conditions. (3) There is a time during the introduction of a new weapon system when the institutionalized training facilities of the Army are unable to provide fully trained and qualified replacement personnel to units equipped with the new system. The third characteristic then is the requirement for the unit to incur the cost of characteristic (1) above for replacement personnel received into the unit prior to the replacement system being able to adequately train and qualify these replacements. With some weapon systems this may always be present while for more sophisiticated systems the deployment of the system may be implemented only after institutionalized training is established.

The end result is that when a weapon system is introduced to a unit and the cost of implementation has not been recognized, then the budget constraint becomes a factor. The unit, to achieve a required level of effectiveness with the system, must expend or consume resources. These resources then are not available for their original planned use. This in turn leads to the familiar restrictions

on supplies or other conservation measures so frequently encountered by units in the field.

In summary, this chapter has defined life cycle costs and shown how they relate to the problem of weapon system deployment and the associated training problem. The following chapter will look at the unit training techniques and their relationship to the Cost and Operational Effectiveness Analysis and the Cost and Training Effectiveness Analysis requirements.

III. CURRENT ARMY TRAINING AND TRAINING ANALYSIS METHODS

A. INTRODUCTION

This chapter begins with an examination of the various types of training analysis methods currently employed in the Army. Such a survey is useful in understanding the types of training problems receiving attention Army-wide. Additionally, it provides insight into the types of analyses conducted during the development phase of the acquisition process and which are used to support proposals to enter the production phase. A brief survey is then conducted of the current training techniques being used, for it is within the framework of these techniques that the training analyses for new weapon systems are conducted. While training in the Army is becoming increasingly dynamic, the techniques discussed

herein provide the reader with an overview of the direction in which unit training is moving. Included also is a description of the Army Training and Evaluation Program (ARTEP), around which all unit training in the Army revolves. The chapter concludes with a description of the TOW weapon system and a discussion of some of the problems generated by its introduction which may have been precluded with better analysis during the development phase.

B. TRAINING ANALYSIS METHODS

The decision to modify or replace an existing weapon system is primarily based on the ability of the new system to increase the effectiveness of the force structure. The problem, then, is to quantitatively assess the degree to which the proposed system contributes to the force structure in terms of measures of effectiveness. There currently exists a fairly well-defined body of literature concerning techniques for measuring hardware performance and associated costs. There does not exist, however, a similar pool of analytical techniques for the measurement of the cost and effectiveness of training. In many instances, the techniques developed for evaluation of hardware appear applicable for evaluation of training.

One of the principal objectives of life cycle costing is to assure that all aspects of a weapon system that require use of scarce resources are addressed in the

analysis that supports the acquisition process. The major components of any weapon system are personnel, training, logistics, hardware, and procedures. Accordingly, each of the five components should be afforded in-depth analysis for the weapon system to be objectively evaluated. Historically, only the hardware portion of the system has been analyzed in terms of cost and effectiveness, with the other components receiving only a cost analysis. Indeed, training has often been regarded as the only peace-time mission the Army has, and therefore costed in a wholly superficial manner. The Cost and Operational Effectiveness Analysis (COEA), an integral part of the acquisition process, establishes rank orderings of alternative hardware systems, however, the other four components have not been integrated into that analysis.

With the formation of the Army's Training and Doctrine Command (TRADOC) in 1974, evaluation of the training component of the weapon system acquisition process was emphasized. The Cost and Training Effectiveness Analysis (CTEA) is now a required document for all prospective weapon systems. The CTEA focuses on parameters that describe training performances and that are clearly related to, ultimately, system performance and combat effectiveness. This requires that a clear "audit trail" be identifiable from the training environment to the combat application.

This requires that training be performance-oriented; that is, the Army must train to perform those tasks required in a combat engagement. This, of course, requires that a system be thoroughly analyzed for accomplishment of a particular objective.[7]

In this analysis the focus is on training effectiveness. Alternative training methods are evaluated to determine the extent to which each permits accomplishment of specific goals or objectives. Typically, a minimum acceptable performance level is determined (performance "floor"). This level is stated in terms of performance objectives, which specify the tasks to be accomplished, the conditions under which they must be accomplished, and the standards which must be attained. Of course, the CTEA must recognize the nature and locale of training as important considerations as these factors materially impact on costs, effectiveness, and system comparisons.

From World War II through the late 1960's, the Army's general model for training was institutionally based. The cycle began in a basic training center and proceeded to a service school which produced MOS-qualified personnel for the units. Training in the units then focused on squad, crew, team, and higher level unit skills. The result was a four-tiered training cycle conducted at three locations:

BASIC INDIVIDUAL TRAINING (TNG CTR)	→	ADVANCED INDIVIDUAL TRAINING (SVC SCH)	→	BASIC/ADV UNIT TNG (UNIT ASGMT)

The premise underlying this concept was one of rapid mobilization, whereby an individual arrived at his unit possessing the individual skills learned in the service schools. The unit, then, provided him the opportunity to practice those skills in a team context.

While this system worked satisfactorily for over 25 years, several factors acted to necessitate a change during the latter portion of the 1960's. Perhaps the most important was the extreme personnel turbulence that occurred during the VietNam War. The twelve month rotation policy caused turnover rates to soar. Accordingly, individuals were afforded precious little stabilized time within a unit to practice newly acquired skills. Additionally, the large manpower requirements impacted adversely on the quantity and quality of baseline expertise within the service schools. Also contributing to the requirement for a change was the proliferation of equipment for any given MOS. The service schools found themselves faced with the necessity of preparing individuals to utilize several different models of the same generic equipment. In addition to the sheer increase in number of different models, the sophistication of each new piece of equipment meant a higher level of

technical skill was required of both operator and maintenance personnel.

These factors quickly pointed to the fact that the institutionally based system could not increase the training of personnel at a rate that was commensurate with the rate of increase in new weapons being fielded. Indeed, this deficiency was noted during the fielding of the most basic of Army weapons, the M-16 rifle. The Ichord Subcommittee of the House Armed Services Committee noted, during an investigation of the M-16's alleged deficiencies, "a lack of adequate training on care and cleaning as a significant deficiency of the weapon" in the hands of the troops.[8]

In reaction to the deficiencies of the institutional approach to training, the Army, in the early 1970's, introduced the concept of "decentralized training". Basically this concept acknowledged that specific skills on specific equipment must be taught at the unit level. That is, the responsibility for a soldier's development of the required level of proficiency on a piece of equipment was that of his company and battalion commander. With the shift in responsibility, higher command training guidance in terms of specific training programs ceased.

In 1974, Headquarters, TRADOC directed each branch school (i.e. infantry, artillery, etc.) to organize a Director of Training Development which would, in effect,

become the "factory" that would export training to the units in the field. This concept recognized that soldiers spend 90% of their time in units, and that it is within these units that he interfaces with specific equipment. Each service school embarked on providing the units with the same basic materials used in the schools. These factories provided self-paced, exportable material to the units so that service school expertise could be available at the point of man-equipment interface. This system enables an individual to transition through various models of equipment without having to return to the service school for training. Additionally, the availability of these training packages enables unit commanders to provide necessary training without establishing local schools that are costly in terms of manpower, time, and equipment.

The result of this system is that, while service schools remain the center of expertise for the various branches of the Army, and continue to conduct advanced individual training, it is recognized that they do not produce experts on all models of equipment for any given MOS. Proficiency is a unit responsibility.[9] Unit commanders must now devote more time to insuring individual skills are acquired at a sufficient level of proficiency to permit the proper functioning of squads, crews, and teams. It is obvious, therefore, that the introduction of a new weapon

system, or even a new model of an old system, involves some degradation of performance until the unit commander can conduct the skill training necessary to reacquire the desired readiness level.

Army training is characterized by being either individual or collective in nature. While the distinction is not always readily apparent, individual training is primarily concerned with preparing an individual to perform tasks associated with a particular military occupational specialty (MOS). Methods of measuring training effectiveness for individuals are widely documented, and the costs associated with the training are maintained by TRADOC for each MOS within the Army. The state of the art of both costing and measuring effectiveness of collective or unit training is a wholly different matter. This training prepares groups of individuals (crews, teams, squads, platoons, companies, etc.) to accomplish tasks as a single entity.

Research in the area of collective training has been on-going for over 20 years. Despite the relative importance of the area, Glanzer and Glaser[10] in 1955 noted that very little formal knowledge existed concerning methods of analyzing and measuring collective performance. They cited the many complexities inherent in such training as being the major stumbling block to effective analysis,

"In the investigation of the areas of team, as opposed to individual, training and performance, problems appear of an entirely new order of magnitude." Indeed, the Defense Science Board stated in 1975, in addressing the difficulty of team training research, that

> This kind of R&D must be piggybacked on operations in the field. Large numbers of R&D personnel are required. The opportunities for data collection during the exercise are marginal, inferential statistics and psychometrics were not designed for this order of complexity. There are limited opportunities for repeated trials and the ultimate test of team training is combat, which cannot be simulated.[11]

The Army is constantly reviewing and analyzing its training methods. Analyses are conducted not only upon introduction of a new weapon system, but also whenever performance deficiencies occur, or when new technological developments appear to have application for training systems. The Army currently uses three basic types of CTEA, each addressing a different training issue. They are (1) Train-up Study (TUS), (2) Training Development Study (TDS), and (3) Training Analysis for COEA (TAC). The TUS is a CTEA conducted to determine if a currently existing performance deficiency can be reduced or eliminated through a revised training program or whether a new operational system is required. It is typically conducted

when there is justifiable reason to believe that an improved training system could materially reduce the force deficiency. Additionally, such an analysis is used when an interim training fix is required prior to the fielding of a new operational system. Caution must be exercised to insure that such analyses are not attempted for a system in which training effectiveness has clearly been optimized. Such studies are typically conducted by the service school that is the proponent for the weapon system.

A TDS is conducted to evaluate and compare training effectiveness, resources, costs, and cost benefits of alternative training systems designed to meet current force training deficiencies. The alternatives examined may involve equipment, strategies, media techniques, or new training technologies. The basic issue of a TDS, then, is to compare alternative training approaches designed to meet specific performance objectives. Most TDSs are conducted in coordination with the Life Cycle Systems Management model application to training system development. While normally not involved with the acquisition process, a TDS may be conducted to establish a baseline effectiveness level against which proposed systems are compared. Responsibility for conducting TDSs normally resides with a service school or other training development agency under TRADOC.

A TAC is conducted in parallel with a material acquisition process COEA. Current policy is aimed at all such analyses being conducted by the TRADOC Systems Analysis Agency (TRASANA). The TAC compares the training costs, resources, and effectiveness of each alternative training system for each weapon system under consideration. These results are then integrated into the COEA to present a more complete picture of the alternatives involved. The TAC effort is, of necessity, a forecast of the characteristics of the training system necessary to train personnel to the minimum proficiency levels which provide for attainment of the performance objectives of the hardware. In many instances the TAC will be used to analyze purely conceptual weapon systems and systems in various stages of hardware development. The complexity of the problem is compounded by these constraints and increase the importance of methodologies with which to deal with the multitude of variables.

While the categories of CTEA are neatly defined, the methodologies involved in the conduct of them are not. Indeed, many Army agencies are in the throes of determining what constitutes effective training. Performance criteria that most CTEA must address are basic issues of military training. These criteria include: initial acquisition of a skill, which is basically a learning curve comparison

of alternative methods; skill retention, which focuses on minimizing forgetting; retraining, reacquisition of a skill level previously learned; and training transfer, comparison of the degree to which skills learned in training transfer to achievement of performance objectives under operational conditions.[12] The last issue is perhaps the most critical, for all training is for naught unless transferable to operational performance.

The training effectiveness analysis phase of a CTEA is conducted in two parts. The first part consists of identifying those items of performance assessment that must be collected for input into the CTEA. The measures of training effectiveness (MOTE) must be selected very carefully, to insure that they provide the requisite data for analysis. Ideally MOTE are measures, scores, or other performance indices related to the task being performed. However, some aspects of the analysis may require the generation of MOTE using subjective data. While ideally the use of subjective MOTE are minimized, current Army tests and evaluations rely extensively on subjective analyses of trainee performance. This results in a lack of standardization which means that evaluations are extremely dependent on the experience/ability of the evaluator. Part two of the training effectiveness analysis involves the actual conduct of the assessment. Critical to this part is the

conduct of sensitivity analysis to assess the impact of various parameters on the training effectiveness.

The cost phase of the analysis must be closely coordinated with the effectiveness phase to insure that cost estimates are valid and reliable. When conducting a TAC, life-cycle cost estimates must be obtained. Personnel costs are a large portion of the training costs, particularly as part of total operating costs. Care must be taken to insure that personnel costs associated with maintenance are not overlooked. In that the system may very well be conceptual, maintenance costs are a prime area for sensitivity analysis. The changes in the operational aspects of unit training costs brought about by the introduction of the new system are a function of how the system compares with the base case.[13] Historically, the introduction of more sophisticated systems indicates an increase in manpower, training time, and/or grade structure. All costs are categorized as research and development, investment costs, or operational costs. Investment costs are defined as all costs associated with producing and procuring equipment, initial organization of personnel, and establishment of the new system. Such investment costs include both recurring and nonrecurring expenditures. Operational costs are limited to those expenditures required to utilize a performance capability or to keep it operational during

its intended life. The distinction here is important, for it is within the category of nonrecurring investment costs that this paper primarily focuses.

This overview of training analyses was presented to indicate the methods currently available for analyzing unit training, and to demonstrate that a system exists to implement the methodology which will be described herein. Indeed, the TAC is the study in which the problem of unit training with new weapon systems must be addressed. Having looked at these studies, an examination of the context in which such analyses are conducted is in order. That is, the type of unit training being conducted throughout the Army must be considered. The next section describes the training environment now prevailing.

C. CURRENT TRAINING TECHNIQUES

In determining unit training effectiveness, the Army agency responsible, TRADOC, devises training techniques and tests designed to facilitate evaluation of a unit's training status. The tests are used to determine, as realistically as possible, the ability of the unit to accomplish its stated missions. Most unit training in the Army is based on information contained in ARTEP publications. It is within these publications that the tasks, conditions, and standards for each mission are enumerated. A more detailed discussion of the ARTEP appears at the end of this section.

With the ARTEP as an outline, training managers are provided considerable information with which to prepare training scenarios to be used in conjunction with the training techniques developed by TRADOC. Among the techniques currently in use within the Army are SCOPES (Squad Combat Operation Exercise, Simulation), REALTRAIN (Realistic Training), MILES (Multiple Integrated Laser Engagement System), the CATTS (Combined Arms Tactical Training Simulator).[14]

SCOPES is designed to teach movement techniques to fire teams and squads. It employs a force on force scenario, with each rifleman having a six-power telescope mounted on his M-16. Additionally, each man wears an identifying number on his helmet. When a number is identified by an opposing soldier he calls out the number and fires a blank round. Controllers then verify the number over the controller radio net, and the soldier identified is "killed". Engagements can thus be conducted wherein the outcome is a direct result of the tactics and techniques employed. An after-action review is held with a discussion of errors made and lessons learned. To a large degree this training technique keeps the subjectivity of the controllers from influencing the outcome.

REALTRAIN permits the use of SCOPES techniques on a larger scale. That is, by mounting telescopes on such

crew-served weapons as TOW, DRAGON and 90mm recoilless refles, engagements can be simulated for opposing forces of platoon or possibly company size. Field tests conducted to date indicate that such engagement simulation techniques permit units to achieve high levels of tactical proficiency more rapidly, while increasing individual soldier motivation through a challenging tactical exercise.

MILES is presently an experimental group of training devices scheduled to be tested in 1978. It employs an eye-safe laser beam to simulate weapon effects and permits the conduct of day and night exercises involving battalion and task force size units. Hit indication devices mounted on likely targets signal "kill" or "near miss". The use of the MILES package permits improved integration of gunnery techniques into tactical training.

The CATTS system, provides simulated combat situations to commanders and their staffs operating from a ground command post. The system employs a Xerox Sigma 9 Computer which permits real-time ground combat simulation, realistic mockups of command post vehicles, actual field radios for communications, on-the-spot command decisions and critiques, and extensive automation to assist controllers. It is currently being used by students attending the Army's Command and General Staff College.

All of the systems discussed are designed to facilitate unit training. As such, they are tied directly to the tasks identified by the ARTEP as being critical to the accomplishment of a unit's mission. The ARTEP is the current standard against which all units are measured.

The basic missions that a type unit must perform are determined by TRADOC, and the essential elements of evaluation for each of these missions are contained in the ARTEP literature that TRADOC publishes. The particular ARTEP that a unit undergoes, that is, the scenario and location of the various events, are determined by a headquarters two levels above that of the tested unit. Typically, the Division staff prepares and conducts the evaluation of battalion-size units. Evaluators are provided for every section of the battalion staff, for each company within the battalion, for each mortar platoon in the rifle companies, and for each special platoon/section found in the combat support company (heavy mortars, reconaissance, ground surveillance, anti-aircraft, and anti-tank). These evaluators are selected from within the Division, and ideally have commanded a unit similar to the one being evaluated. Evaluation teams consist of 40-50 men, and as such are considerably expensive in terms of manpower. Each battalion-size evaluation consumes approximately three weeks of the evaluator's time with pre-test planning,

conduct of test, and post-test critique and reporting. Recognizing that a Division must conduct a minimum of nine such tests annually (one for each line battalion), it is readily apparent that a full-time testing office within the Division staff is necessary to coordinate the workload.

The test itself is conducted in two phases. During the initial or small unit evaluation (SUE) phase, squads from the rifle platoons in each company, mortar squads, anti-tank sections, scout sections, ground surveillance teams, and anti-aircraft teams are selected at random by the evaluators and required to perform specific missions. These tasks normally require from a few hours to 24 hours to conduct. Phase 1 normally lasts two days. During Phase II, the entire battalion deploys on a field exercise and performs as a battalion those missions designated by the evaluators. In addition to evaluating the ability of the battalion to function as a cohesive unit during this phase, platoons are also selected at random to conduct independent operations and then return to battalion control. This phase of the test normally lasts 3-4 days.

During the SUE phase, many of the required tasks lend themselves to objective evaluation, such as number of hits per weapon and elapsed time for the 12 mile road march. However, nearly all tasks conducted during the battalion deployment phase are evaluated on a subjective, "go-no go"

basis. This leads to inconsistencies in scoring because it places the burden of evaluation squarely on the professional judgment of the evaluator. Indeed, in the ARTEP Validation Report conducted by the Army Research Institute in 1974, it was concluded that the ARTEP, in its present form, is not a standardized test instrument. The report continued,

> There is no reason to expect that different teams would be evaluated under the same conditions when using ARTEP guidance and standards. The standards are too subjective and evaluator performance is too erratic. There is no explanation of how to relate task performance to over-all mission performance or how to adjust standards to account for varying test conditions.[15]

Aircraft teams are selected at random by the evaluators and required to perform specific missions. These tasks normally require from a few hours to 24 hours to conduct. At the conclusion of this phase, normally two days in duration, the entire battalion deploys on a field exercise and performs missions designated by the evaluators. In addition to evaluating the ability of the battalion to function as a cohesive unit, during this phase platoons are selected at random to conduct independent operations and then return to battalion control. This phase of the test normally lasts 3-4 days.

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Despite these shortcomings, the ARTEP does establish a performance floor that is currently recognized by Department of the Army as the minimum acceptable effectiveness level. Detailed critiques are provided to commanders by the evaluation team following the exercise. The contents of this critique form the nucleus for unit training in the ensuing months. It is the ability of the ARTEP to identify

problem areas down to squad and team level that makes it an attractive form of evaluation.

Illustration of how the foregoing discussion on training analysis and training techniques impacts on the training cost of a newly introduced weapon system will appear in the next chapter. However, for clarity the TOW system is described in the next section to permit the reader to view the changes in unit training dictated by the system. The following section also includes a discussion of a current training evaluation which pointed out problems with the system used for TOW training.

D. THE TOW WEAPON SYSTEM

The training techniques and concepts discussed are designed to provide realism and aid the unit commander in forging a combat ready force. Advancing technology has required commanders to continuously analyze the traditional concepts of tactical warfare as weaponry available to them becomes increasingly sophisticated. Perhaps no weapon has impacted as greatly on infantry tactics in the past thirty years as has the TOW; a tube launched, optically tracked, wire command linked guided missile system. The TOW is the heavy anti-tank weapon of the Army and is capable of delivering first round accurate fire against targets from 65 to 3000 meters. It is used to destroy formations of armored vehicles, field fortifications, and emplacements.

The TOW replaced the 106mm Recoilless Rifle, and its operation is simplified in comparison with earlier systems. With an encased missile inserted in the launch tube, the gunner performs only the following steps: (1) visually selects a target, (2) aligns the optical sight on the target by use of control knobs, and (3) while tracking the target, presses the firing trigger. With the gunner keeping the crosshairs centered on the target during flight, the TOW missile is automatically guided to target impact.

Benefits of the TOW include reduction in gunner error with the TOW guidance system, simplified gunner training, and a greatly increased hit capability against moving targets at all ranges between 65 and 3000 meters. Additionally, the TOW launcher reduces weight over the 106mm rifle from 460 to 171 pounds and increases the effective range from 1100 to 3000 meters.

The TOW squad consists of a four man crew, a squad leader, gunner, assistant gunner, and driver. The TOW can be fired from a ground mounted position, or from a mount on an armored personnel carrier or 1/4 ton truck (jeep). Each of the three rifle companies in an infantry battalion has two TOW squads, and the Anti-Tank Platoon of the Combat Support Company has 12 squads. Thus the Battalion Commander is faced with training and employing 18 TOW squads.

In December, 1976 the United States Army Infantry School conducted an evaluation of TOW training based on data collected from units serving in Europe. The driving force behind the evaluation was a concern that unit TOW training programs were ineffective insofar as training the soldiers to a level which would allow maximizing the capability of the weapon on the modern battlefield. This evaluation was conducted using a synergistic logic combining the total weapon system (total weapon system = soldier + training + weapon) and battlefield effectiveness (B_E = weapon x proficiency x tactic/technique of employment). The "weapon" is constant in both formulae, soldier + training yields proficiency, and tactic or technique of employment calls both of the former together with current doctrine for effective employment of the system.[16] The study then proceeded to examine the five major areas of a weapon system: soldier, training, weapon, proficiency, and tactics of employment.

The major finding of the evaluation was that TOW gunner selection criteria was critical in improving the effectiveness of the weapon. Indeed, the report states:

> ... training can be the 'fix' which causes actual effectiveness to approach designed effectiveness, but the link between training and the weapon is the man. The properly selected trainee may be able to do more to 'fix' the gap than an expensive but artificial and

> unwarranted change in the training program. The bottom line, then, in the case of sound training programs, is that it may be cheaper, better, quicker, and have all the external benefits of placing a man in the job he is suited for, if we properly select our TOW gunner trainees.
>
> Proper trainee selection can close the retention gap and give the trainee the option of either doing more training in less time or getting more proficiency for a fixed amount of training time. Obviously, once we place the correct man in training we realize the economics of reducing the retention gap regardless of whether we opt for more training in fixed time, same training in less time, more proficiency in less time, or an appropriate mix of these.[17]

This observation suggests that the Commander, in addition to training TOW gunners and crews, must pay particular attention to the selection of troops to fill these key positions. With the reduction in institutional training by the service schools, and the elimination of a separate military occupational specialty for direct fire crewman, the commander now is forced to select TOW crew members from among his infantry riflemen. This screening process, which had been conducted by training centers prior to the shift in emphasis away from institutionalized training, requires additional time and resources for the unit commander, as the unit typically receives very few school-trained crewmen. The nature of the TOW is such that one cannot assume a crewman for the 106mm recoilless

rifle will be a suitable TOW crewman. While the Infantry School study suggests that gunner selection is the single most critical variable, many units in Europe were found to have no formal selection process, but rather a random fill of vacant positions.

The study included interviews with over 400 men serving in TOW positions from 12 different infantry battalions. Not surprisingly, only 39% had received any formal TOW training in a school exclusively for TOW outside the unit environment. The study team administered a tactics test to this population consisting of 12 questions concerning employment of the TOW. The aggregate score on all questions was a discomforting 52%. The study states, "Based on these data, the only possible conclusion is that TOW units are not tactically proficient with TOW insofar as knowing and/or understanding basic tactics and techniques of employment are concerned."[18] This statement is made about the most important single weapon to enter the Infantry's inventory in 30 years! It is true that the introduction of TOW has caused infantry leaders to rethink basic tactics. The 3000 meters of range for direct fire is so alien to infantry thinking that commanders are bewildered by the myriad of possibilities it now affords them. No longer are targets over 1000 meters out the problem of mortar and artillery men along! This threefold increase in

responsibility has necessitated a revamping of concepts that has been slow in evolving.

To the extent that the Army has failed to train its leaders in employing the TOW, has that failure been transferred to TOW platoons and squads. An apparent failure to recognize the impact of the introduction of TOW on the battlefield has resulted in serious training deficiencies throughout the Army. While the concept of unit responsibility for training on specific weapons may have some merit, to require such training when the unit does not have the requisite expertise is folly. Battalion and company commanders are and should be held accountable for the training status of their units, however the Army is accountable for providing the wherewithal to conduct that training when new weapon systems are introduced. A failure to do so is indicative of a lack of planning for training and its concomitant costs during the acquisition process. The result is that we have an inadequate number of trained resources in TOW units in terms of technically trained personnel and leader/trainers who are sufficiently trained to train others. Only 41% of the leader/trainer population is school trained, and only 21% of the individuals occupying the critical squad leader positions have received formal TOW training.[19]

This chapter has described the various analyses of training currently ongoing within the Army in support of weapon system acquisitions and modifications. Discussions of the ARTEP and current unit training techniques being employed were included to provide the reader with a notion of the increased complexity of unit training. Additionally, the TOW was described in some detail in an effort to portray the impact of externalities in unit training. Indeed, with weapon systems and training techniques becoming increasingly sophisticated, the costs associated with units becoming proficient with the new systems will inevitably increase. While these costs do not appear to be a significant portion of total life cycle costs, they are significant costs at the division and battalion levels and should therefore be estimated and included in funding considerations. To impede training because costs were not anticipated, and funds therefore not available, is avoidable. In the next chapter an examination of two models currently being studied by the Army to estimate unit training costs is presented. Additionally, the authors present their methodology for estimating these costs using currently existing systems.

IV. TRAINING COSTS ASSOCIATED WITH NEW WEAPON SYSTEMS

A. INTRODUCTION

This chapter will introduce those facets of training which require the use of resources and will discuss how they apply to the problem addressed by this paper. After this introduction, a discussion of the Training Management Control System (TMCS) will develop the premise that current inputs to that system can be used to develop cost estimates to be used within the life cycle cost model for evaluating competing weapon systems during development.

The research conducted for this thesis indicates that there are currently two methods being used in an effort to estimate training costs at the unit level. These two methods are the National Training Center Model and the Army Training Study approach. These methods are discussed below to develop for the reader an appreciation of the complexity of defining all of the true costs associated with training in a unit. What will be further developed is that while the full cost is necessary for inclusion in the decision making process, it is nearly impossible to derive by either approach. Conversations with members of the National Training Center indicated that there are eight (8) resources which must be addressed in determining training costs. They are: (1) personnel, (2) land, (3) fuel, (4) equipment, (5) facilities, (6) software, (7) ammunition, and (8) money (funds).

The Army Training Study Group, currently in session, is looking at only two of these factors for estimating training costs - money and personnel, plus the additional resource of time.

The above approaches are not yet defined as Army policy and there is no information as to whether either will achieve that status. Therefore the reader is cautioned not to draw any conclusions outside those drawn by the authors. These two approaches are presented here to impact a sense of the complexity of the issue: yet offer a rather simple procedure to accomplish the estimate.

B. THE NATIONAL TRAINING CENTER MODEL

The National Training Center Model requires that an industrial engineering type estimate be developed. That is, cost estimates are made for each of the components of a weapon system and then aggregated.

Input 1 is personnel. The personnel requirements for a unit can be developed logically from the official Table of Organization and Equipment. (TO&E) If there is no approved TO&E for the type system, one must be developed. Personnel cost estimates based on skill/grade changes as determined by the conceptual employment of the weapon system, can be used prior to the approval of a change in the TO&E. The lack of an approved TO&E is expected under the TRADOC policy of performing CTEA during the development phase of a weapon system acquisition.

Input 2 is land, or more precisely, training land. Development of a cost estimate for this input requires that the developer assess whether or not the units which will eventually receive the weapon system possess, or have access to, sufficient training land to allow the conduct of meaningful training with the weapon system. Obviously, this requires data concerning what units will receive the weapon system, where they will be stationed when the weapon system is issued, what training lands are at that location, and the cost of obtaining additional land if required. Training Circular (TC) 25-1 (draft) from TRADOC presents a very thorough evaluation of the importance of training land needs for a modern army. It further analyzes what effectiveness could be gained by developing a National Training Area with sufficient land to train with all weapon systems.

Input 3 is fuel (POL). Considering the complexities of other inputs, this one is rather straightforward. Using the conceptual or specified range characteristics, the consumable expenditure can be directly computed parametrically. This particular input need not be limited to POL, but could easily be extended to all consumables such as repair parts by use of the Mean Time Between Failures (MTBF) characteristics of the weapon system. Actually, this extension to repair parts may prove to be extremely valuable, in that an impact on projected training time may be found

by way of the amount of repair time required or the operationally ready time on the weapon system.

Input 4 is equipment. An estimate for the cost of equipment can generally be derived from current budgets. This will be the cost of equipment used in support of training, both by the unit and by its support units. These estimates will be similar to those for fuel in that time and some type of MTBF calculation must be determined.

Input 5, facilities, is another difficult resource to assess. Like land, this estimate requires data on units to receive the weapon system and their location when they receive it, along with a facilities evaluation of that location. Facilities are defined to include storage, maintenance, training, and security facilities depending on the weapon system requirements.

Input 6, software, refers to those support requirements other than hardware specified in the list of inputs. This could include the use of trainers, training systems which are computer-assisted or use some other software system either directly involved in the weapon system or in support of it at a base level.

Input 7 is ammunition requirements, which can be estimated from the training system specifications being developed for the weapon system.

Input 8, money, refers to any direct budgetry impacts which would result from the introduction of a weapon system. Of interest would be such things as the projected cost of transporting the system, sending personnel on temporary duty for training as instructors, having to add to the civilian labor force to support the weapon system, or the requirement for additional training money for elements not addressed above.

As can be seen from the presentation of this model, a "bottom-up" estimate for the costs of re-establishing a unit's readiness following the introduction of a weapon system can be developed, i.e. training costs = 1+2+3+4, etc. This aggregation will be based, in part, on parametric estimates which are functions of the weapon system's particular characteristics such as range, MTBF, operating hours, etc. To amplify further, some of the eight input costs will be affected in a nonlinear fashion due to the weapon characteristics. For example, the increase in the range of the TOW over the 106mm recoilless rifle was nearly three times, but the land required for training was greater than just the multiple of three because of greater safety requirements at the longer ranges. This added factor presents a formidable task for any cost analyst to be able to present a meaningful estimate, especially during the development stage of a weapon system.

C. THE ARMY TRAINING STUDY APPROACH

This approach more nearly fits the description of a parametric cost estimate. Using the three factors of time, money, and personnel, costs are estimated as a function of their interrelationships. However, this approach is not numerically definitive, but rather is descriptive in nature.

The development of this approach corresponds to the varying emphasis upon each factor as the organizational level involved is changed. That is, a company conducting unit training is most concerned with time as a constraint, as the company commander has little control over the amount of money provided his unit and little control over the personnel assigned. At the battalion level, the next level of aggregation in the hierarchy, the emphasis appears to change. While the battalion commander does have more influence on money allotted to his command, his influence is still very constrained. His concern about time becomes that of scheduling facilities rather than time to conduct specific tasks. Therefore, the primary concern becomes that of personnel. His influence over this resource is relatively greater than over time or money, which means cost estimates from this level will emphasize the personnel aspect to a greater degree.

The emphasis on personnel continues to the division level, approximately. From above the division level to

the Secretary of Defense level the key resource becomes money. Time has no meaning at this level of program management, and personnel are relatively unimportant in that the structure of the forces is usually exogenous to any program considerations. Therefore, any estimate will be driven primarily by budgetary considerations.

The problem with this approach becomes one of tying the different viewpoints into a recognizable and acceptable estimate of the costs. Basically the estimate will be:

(1) training = time available at the company level,

(2) training = time facilities are available + qualifications of personnel + skill/grade authorizations versus actual assigned at the battalion/division,

(3) training = money at Army/DOD level.

Attempts to use this method to estimate costs early in the development phase would be unreasonable.

D. OTHER CONSIDERATIONS

The key point which must be kept in mind in any concept or methodology employed is that the objective is to estimate the cost of returning a unit to a specified level of readiness after a weapon system has been operationally deployed with that unit. The problem is that there is currently no linkage which provides a means of calculating training requirements relative to readiness requirements.

While the National Training Center and Army Training Study approaches described shed some light on the problem, they do not provide a means of reaching the above objective. They do provide more insight than does the life cycle cost model, although these aspects could be added to LCC under appropriate cost elements. The current life cycle cost structure does not account for these costs in the correct place. The additional cost of re-establishing unit readiness levels should be a category under operating and support costs. A methodology for development of these costs is presented in the next section.

The current elements in the operating and support category are shown at Figure 4. As can be seen from the preceding figures (2 and 3), there are cost elements under Research and Development and under Investment which have labels indicating content similar to those discussed.

The costs included in the Research and Development categories of Training and Facilities are not the same as discussed herein. (Fig. 2) Included in Training are those costs associated with design, development, and production of <u>prototype</u> training devices; and the cost of training service <u>test</u> crews and maintenance personnel. The Facilities element includes costs associated with facilities required to be acquired or converted for use in the <u>development</u> and <u>testing</u> of the weapon system.

LIFE CYCLE COST COMPONENTS

RESEARCH AND DEVELOPMENT

- DEVELOPMENT ENGINEERING
- PRODUCIBILITY ENGINEERING AND PLANNING
- TOOLING
- PROTOTYPE MANUFACTURING
- DATA
- SYSTEM TEST AND EVALUATION
- SYSTEM/PROJECT MANAGEMENT
- TRAINING
- FACILITIES
- OTHER

FIGURE 2

LIFE CYCLE COST COMPONENTS (CONTINUED)

INVESTMENT

NON-RECURRING INVESTMENT

PRODUCTION

ENGINEERING CHANGES

SYSTEM TEST AND EVALUATION

DATA

SYSTEM/PROJECT MANAGEMENT

OPERATIONAL/SITE ACTIVATION

TRAINING

INITIAL SPARES AND REPAIR PARTS

TRANSPORTATION

OTHER

FIGURE 3

LIFE CYCLE COST COMPONENTS (CONTINUED)

OPERATING AND SUPPORT

MILITARY PERSONNEL

CREW PAY AND ALLOWANCES
MAINTENANCE PAY AND ALLOWANCES
INDIRECT PAY AND ALLOWANCES
PERMANENT CHANGE OF STATION

CONSUMPTION

REPLENISHMENT SPARES
PETROLEUM, OIL, AND LUBRICANTS

DEPOT MAINTENANCE

LABOR
MATERIAL
TRANSPORTATION

MODIFICATIONS, MATERIAL

OTHER DIRECT SUPPORT OPERATIONS

MAINTENANCE, CIVILIAN LABOR
OTHER DIRECT

INDIRECT SUPPORT OPERATIONS

PERSONNEL REPLACEMENTS
TRANSIENTS, PATIENTS, AND PRISONERS
QUARTERS, MAINTENANCE AND UTILITIES
MEDICAL SUPPORT
OTHER INDIRECT

FIGURE 4

The Investment elements (Fig. 3) related to training include the costs of design, development and production of training equipment and the cost of training service instructors and initial crew and maintenance personnel. The costs of training replacement personnel is excluded here to be collected under Operating and Support costs. The operational/site activation element would be appropriate for including the costs of providing adequate facilities for units receiving the weapon system.

The discussion above indicates that the current system does provide a means for categorizing the training cost data required to develop Life Cycle costs for a weapon system. What is needed is the ability to determine the cost of unit training necessitated by reduction in unit readiness that occurs when a new weapon system is deployed. The following section offers a methodology for addressing this situation.

E. TRAINING MANAGEMENT CONTROL SYSTEM

The Army has traditionally had difficulties in quantifying the costs associated with unit training. Commanders have been required to plan extensive training programs based on wholly insufficient data pertaining to the cost of the programs. Additionally, the Army has experienced significant difficulties in justifying funds for training before Congressional committees. This has been largely

due to the fact that the Army has been unable to provide sufficient data to the committees concerning the cost of the training desired, and the benefits to be derived from the training. That is, the task is one of developing a system which expresses what we are buying rather than one which merely identifies what we are paying for. The Navy has been able to rely on "steaming days" as a measure of costs and benefits of training funds; and the Air Force uses "flying hours" in the same manner. Unfortunately the Army's training does not fit into such neat, concise packages. Accordingly, after the funds have been allocated, the Army may not have received what it considered it "fair share", but is unable to argue the point logically.

The fact is not new that budget cuts are frequently mistaken as "savings" generated by efficiencies, rather than being recognized as the program cuts for which they are. In his book, Program Budgeting: Theory and Practice, Dr. Frederick C. Mosher offers the following:

> "... a very large part of the economy reductions in, for example, the Army appropriations, actually come out of a program rather than out of economics in the execution of the program. This fact may be disguised to some extent by retaining the basic program but putting off to future years its accomplishment, such as President Truman's determination in his 'stretchout'. Or it may be concealed in the Budget Bureau's or the Congress' substitution of their judgment for the military department

judgment as to what is needed ...
But in the vast majority of cases, what is reduced is what is bought and done; it is at least doubtful that reductions usually result in the buying and doing of the same things at less cost."

Adding to the problem of resource justification to both OSD and the Congress are the historical precedents established by the Army. OSD and the Congress have observed significant fluctuations in the amount of resources provided to major commands with no reported change in their training proficiency. The Army announces that the majority of its units are rated training ready, by its own definition, and yet continues to state requirements for additional resources to improve the training readiness of those units. It is not difficult to understand the difficulty opponents have in accepting this paradox. The Army would be on much firmer ground when requesting additional training resources if some increased output or a manifestation of the return on the investment of the additional resources could be exhibited. The same reasoning applies when developing training requirements and costs for new weapon systems.

In 1977 the Vice Chief of Staff directed FORSCOM to identify the cost of field training and quantify that cost in terms of Battalion Field Training Days (BFTD). A BFTD is defined as 8-24 hours of mission related training conducted by a battalion with sufficient personnel and

equipment to accomplish its training task outside its assigned billeting, administrative, and logistical areas. For example, a battalion ARTEP training event of 10 hours duration would be reported as one BFTD. Company and platoon field training would be reported proportionally. In a battalion of five companies with four platoons each, a company field training day would be reported as 1/5 BFTD, and a platoon field training day would equal 1/20 BFTD. The BFTD is to become the Army's "steaming days" and "flying hours", and as such is the Army's proxy for combat effectiveness. It is foreseen that budget justification will be facilitated by the Army's exhibiting an ability to quantify the amount of training purchased with specific funding levels. Additionally, the system would provide an important management tool for battalion, brigade, and division commanders by enabling them to determine the training program that maximizes the use of available resources.

Charged with this responsibility, FORSCOM has developed the Training Management Control System (TMCS), designed to provide commanders with sufficient data concerning the cost of training so that realistic annual training programs can be developed.[20] Additionally, the system permits a separation of training funds to sustain active units in the mission funding account. This ability to accurately depict the funds needed for training alone will greatly facilitate justification of requests and expenditures.

There are several collateral benefits realized from this system. It has necessitated the development of valid equipment operating cost factors. Such factors will enable the Army to accurately charge for use of its equipment in support of outside activities, much as the Air Force charges for the use of its aircraft. A traditional source of difficulty has been forecasting ammunition requirements necessary to support annual training programs. An inability to predict the types of exercises that would be conducted has been a major obstacle to accurate forecasting. TMCS eliminates much of the guesswork involved in this process by enumerating the field training to be conducted and also permits updating of requirements as the training program is modified. The assignment of training areas has been simplified. TMCS identifies the acreage needed for given types of tactical maneuvers and thereby reduces the chances of training areas being improperly proportioned to accommodate unit exercises. Land availability has become an increasingly significant problem as weapon systems with greater ranges enter the inventory. Additionally, the extensive manual recording efforts necessary to maintain battalion level data concerning dollars and POL consumed is eliminated with TMCS. The battalion commander now has data readily available indicating the resources remaining with which to conduct his training program.

The TMCS operates with minicomputers located in the Division and Brigade headquarters. It is essentially a linear program which maximizes the number of battalion field training days available for a given set of tactical exercises, subject to constraints on funds, space, time, flying hours, ammunition, and POL. Linearity of the objective function was assumed, and through testing conducted thus far appears to be appropriate.

Input forms and output generated by the system are shown in Figures 5-8. Figure 5 contains information provided by each battalion, for each event (i.e. attack, defense, etc.) it desires to conduct during the forthcoming fiscal year. The data includes unit size, number of personnel participating, duration of the exercise, physical size of the area required, and a listing of equipment and ammunition to be used. This data is entered in the model along with the constraints shown at the top of Figure 6. The model then generates the number of BFTD-equivalents each event represents, as shown in the lower section of Figure 6. Having done this, the model then provides for each battalion, by event, the training that can and cannot be conducted under the given constraints as shown in Figure 7. The top portion of that figure depicts each training event that can be conducted, and the quantity of each resource required to execute it.

The lower portion depicts that training that cannot be conducted due to insufficient quantities of one or more resources. The model then makes available to the Division Commander the information shown in Figure 8. This depicts aggregate training, in terms of BFTDs, that each of his units can conduct under existing constraints. Additionally, he is provided with the total fixed (garrison) and variable costs associated with each unit's training.

Armed with this information, zero based budget development and justification is greatly enhanced. Having quantified data for total field training resources required permits the Division Commander to prepare contingency training plans for various funding levels. TMCS also provides a Division allocation of dollars, POL, flying hours, and maneuver areas to the battalion; it provides the Division with ammunition requirements by type in both rounds and dollars; provides each an automated update capability; provides equipment, ammunition, and maneuver area requirements by training event as well as dollars, POL, and flying hours to conduct each event; identifies training which can and cannot be conducted and resources estimates associated with each; and it provides the data with which to develop an automated range and maneuver area scheduling subsystem based on battalion annual training programs.

TEST
TRAINING INFORMATION WORKSHEET

MECHANIZED INFANTRY BN

ORGANIZATION |____________|

DATE |____________|

EVENT |_______________| LIMIT TO 12 CHAR-#FIRST IF MULTIPLE EVENTS

UNIT SIZE |____| 1 - SQD,SEC; 2 - PLT; 3 - CO; 4 - BN; 5 - OTH

ARTEP LEVEL |____|

EVENT LIMIT |____|

OPT TYPE |____| 0 - OPT TYPE; 1 - REQ TNG

LOCATION |____________| 1-FIELD; 2 - RANGE; 3 - GARRISON

NO PERS PART |____| EVENT PRIORITY |____| DATE FROM |_____| DATE TO |_____| DURATION |______| HOURS NO UNITS |____| RANGE REQ(OPTM) |____X____| RANGE AVAIL |____X____|

VEHICLES					WEAPONS						
	NOMENCLATURE	AUTH	NO PART	AVG MI /VEH		NOMENCLATURE	AUTH	CAL AMMO	NO.	AVG RD /WPN	AVG MI /WPN
1 -	CARRIER.M577	7			31 -	CARR.M125.81MM	9	81			
2 -	CARRIER.M113	59			32 -	CARR.M106.107MM	4	4.2			
3 -	RECOV.VEH.M578	6			33 -	CARR.TOW	22	TOW			
4 -	TRK.AMB.5/4 TON	1			34 -	LAUNCH.GREN	95	40			
5 -	TRK.CGO.5/4 TON	7			35 -	LAUNCH.ROCK	9	66			
6 -	TRK.CGO.2 1/2T	14			36 -	MG.VEH.MTD	97	50			
7 -	TRK.CGO.2 1/2T W	2			37 -	MG.GND.MTD	26	50			
8 -	TRK.CGO.5 TON	6			38 -	MG.LT.M60	49	7.62			
9 -	TRK.5TON.W/W	9			39 -	PISTOL	116	45			
10 -	TRK.UTIL.1/4 T	34			40 -	RIFLE.M16	731	5.56			
11 -	WRECKER.5 TON	1			41 -	SUB MG	45	45			
12 -					42 -	TRACK.SU36	40	DGN			
13 -					43 -						
14 -					44 -						
15 -					45 -						
16 -					46 -						
17 -					47 -						
18 -					48 -						
19 -					49 -						
20 -					50 -						

OTHER EQUIPMENT					OTHER COSTS			REMARKS	
	NOMENCLATURE	AUTH	NO.	AVG MI/HR.		NOMENCLATURE	COSTS		
21	-RADAR.AN/PPS5	4			1 -			1 -	
22	-RADIO.AN/PRC77	12			2 -			2 -	
23	-GEN.5KW.60HZ	1			3 -			3 -	
24	-GEN.5KW.400HZ	4			4 -			4 -	
25	-GEN.1.5KW.60HZ	13			5 -			5 -	
26	-GEN.1.5KW.DC	2			6 -			6 -	
27	-COMP.(ALL)	5			7 -			7 -	
28	-RTT	1			8 -			8 -	
29	-				9 -			9 -	
30	-				10 -			10 -	

• COMPLETED FOR ALL COMBAT AND COMBAT SUPPORT BATTALIONS

Figure 5

PROBLEM ID. ..... 1-10 MECH INF

RESOURCE LIMITS	MIN	MAX
AVSPARES $	0.00	0.00
AVGAS $	0.00	0.00
MOGAS $	0.00	3535.00
SPARES $	0.00	133500.00
DIESEL $	0.00	20971.00
OTH COST $	0.00	0.00
FLY-HRS	0.00	0.00
BFTD	0.00	241.00
ACRE DAYS	0.00	845827.00

TRAINING RESOURCE LIMITATIONS FOR 1-10 MECH INF BN

EVENT LIMITS	MIN BFTD'S	MAX BFTD'S
EIB	0.00	3.00
MOBA	0.00	2.00
AIR MOB TNG	0.00	3.00
1 BN EDRE	0.00	3.00
2 BN EDRE	0.00	3.00
3 BN EDRE	0.00	3.00
4 BN EDRE	0.00	1.00
1 BN CPX	0.00	1.00
2 BN CPX	0.00	1.00
3 BN CPX	0.00	1.00
1 TEWT	0.00	.01
2 TEWT	0.00	1.00
EXT EVAL	0.00	9.00
INT EVAL	0.00	11.00
1 BN SUE	0.00	4.00
2 BN SUE	0.00	4.00
1 BN FTX	0.00	4.00
2 BN FTX	0.00	4.00
3 81 QUAL	0.00	.50
2 81 QUAL	0.00	.50
1 81 QUAL	0.00	.50
3 4.2 QUAL	0.00	.01
2 4.2 QUAL	0.00	.01
1 4.2 QUAL	.01	.01
1 M16 QUAL	0.00	1.00
2 M16 QUAL	0.00	1.50
1 7.62 QUAL	0.00	.50
2 7.62 QUAL	0.00	.50
1 TOW PRAC	0.00	.01
2 TOW PRAC	0.00	1.00
3 TOW PRAC	0.00	.01
3A TOW PRAC	0.00	1.00
4 TOW PRAC	0.00	.01
7 TOW PRAC	0.00	.01
9 TOW PRAC	0.00	.01
10 TOW PRAC	0.00	.01
8 TOW QUAL	0.00	1.00
6 TOW QUAL	0.00	1.00
5 TOW QUAL	.01	.01
TASKINGS	0.00	5.00

COMPUTER DETERMINED BATTALION FIELD TRAINING DAY EQUIVALENTS FOR EACH EVENT

(SEPARATE FORMULA FOR EACH TYPE COMBAT / COMBAT SUPPORT BATTALION)

REQUIRED TRAINING BY DIVISION OR HIGHER HEADQUARTERS

Figure 6

TRAINING THAT CAN BE CONDUCTED: (LINEAR PROGRAM OUTPUT)

	AVSPARES $	AVGAS $	MOGAS $	SPARES $	DIESEL $	OTH COST $	TOTAL $	FLY-HRS	BFTD	ACRE DAY	%-CONT.
EIB	0.00	0.00	203.06	3026.68	248.18	0.00	3477.92	0.00	3.00	5928.00	1.31
MODA	0.00	0.00	0.00	1268.52	236.11	0.00	1504.63	0.00	2.00	1976.00	2.30
AIR MOB TNG	0.00	0.00	68.82	555.68	32.04	0.00	656.54	0.00	3.00	8892.00	1.97
1 BN EDRE	0.00	0.00	47.44	2029.66	315.83	0.00	2392.93	0.00	3.00	8892.00	2.96
2 BN EDRE	0.00	0.00	47.44	2216.56	341.92	0.00	2605.92	0.00	3.00	8892.00	2.63
3 BN EDRE	0.00	0.00	47.44	2232.70	344.66	0.00	2624.80	0.00	3.00	8892.00	2.30
4 BN EDRE	0.00	0.00	47.44	2390.30	365.63	0.00	2803.37	0.00	1.00	8892.00	1.97
1 BN CPX	0.00	0.00	34.85	516.56	42.15	0.00	593.56	0.00	1.00	247.00	2.47
2 BN CPX	0.00	0.00	34.85	516.56	42.15	0.00	593.56	0.00	1.00	247.00	2.30
3 BN CPX	0.00	0.00	32.11	527.84	43.02	0.00	602.98	0.00	1.00	247.00	2.14
1 TEWT	0.00	0.00	115.02	723.84	3.95	0.00	842.81	0.00	.01	0.00	2.63
2 TEWT	0.00	0.00	115.02	820.44	19.45	0.00	954.91	0.00	1.00	26676.00	2.47
EXT EVAL	0.00	0.00	636.68	32087.48	5424.60	0.00	38148.76	0.00	9.00	54587.00	2.71
INT EVAL	0.00	0.00	922.43	34394.88	5504.40	0.00	40821.71	0.00	11.00	54587.00	2.93
1 BN SUE	0.00	0.00	200.85	15598.72	3012.34	0.00	18811.91	0.00	4.00	54587.00	2.96
1 BN FTX	0.00	0.00	320.26	12582.14	1961.55	0.00	14863.95	0.00	4.00	31616.00	2.96
2 BN FTX	0.00	0.00	313.08	12307.91	1908.20	0.00	14529.19	0.00	4.00	31616.00	2.71
3 81 QUAL	0.00	0.00	20.04	404.42	63.87	0.00	488.33	0.00	.50	5928.00	2.71
2 81 QUAL	0.00	0.00	8.48	388.66	63.87	0.00	461.01	0.00	.50	5928.00	2.80
1 81 QUAL	0.00	0.00	8.48	388.66	63.87	0.00	461.01	0.00	.50	5928.00	2.96
1 4.2 QUAL	0.00	0.00	3.85	254.50	38.59	0.00	296.94	0.00	.01	6916.00	2.96
1 M16 QUAL	0.00	0.00	12.23	175.14	27.60	0.00	214.97	0.00	1.00	1235.00	2.47
2 M16 QUAL	0.00	0.00	12.23	175.14	27.60	0.00	214.97	0.00	1.50	1235.00	2.63
1 7.62 QUAL	0.00	0.00	7.81	107.26	12.25	0.00	127.33	0.00	.50	2964.00	2.14
2 7.62 QUAL	0.00	0.00	7.81	107.26	12.25	0.00	127.33	0.00	.50	2964.00	1.81
2 TOW PRAC	0.00	0.00	4.24	61.52	97.91	0.00	163.67	0.00	1.00	988.00	2.96
3A TOW PRAC	0.00	0.00	4.24	61.52	97.91	0.00	163.67	0.00	1.00	5928.00	2.96
8 TOW QUAL	0.00	0.00	4.24	61.52	97.91	0.00	163.67	0.00	1.00	988.00	2.47
6 TOW QUAL	0.00	0.00	4.24	61.52	97.91	0.00	163.67	0.00	1.00	988.00	2.63
5 TOW QUAL	0.00	0.00	6.94	120.48	106.55	0.00	233.97	0.00	.01	5928.00	2.96
USED	0.00	0.00	3291.63	126164.07	20654.26	0.00	150109.96	0.00	63.03	354692.00	76.72
LIMIT	0.00	0.00	3535.00	133500.00	20971.00	0.00	158006.00	0.00	241.00	845827.00	
UNUSED	0.00	0.00	243.37	7335.93	316.74	0.00	7896.04	0.00	177.97	491135.00	

CONSTRAINT

TRAINING THAT CANNOT BE CONDUCTED:

PARTIAL SOLUTIONS IN LP "FINE TUNE" WITH ROBIN

	AVSPARES $	AVGAS $	MOGAS $	SPARES $	DIESEL $	OTH COST $	PRIORITY	FLY-HRS	BFTD	ACRE DAY	%-CONT.
2 BN SUE	0.00	0.00	205.40	15577.46	4159.01	0.00	8.50	0.00	4.00	54587.00	2.80
3 4.2 QUAL	0.00	0.00	1.93	242.10	38.59	0.00	8.25	0.00	.01	6916.00	2.71
2 4.2 QUAL	0.00	0.00	1.93	242.10	38.59	0.00	8.50	0.00	.01	6916.00	2.80
1 TOW PRAC	0.00	0.00	5.40	63.96	67.02	0.00	7.50	0.00	.01	7904.00	2.47
3 TOW PRAC	0.00	0.00	4.24	58.12	67.02	0.00	8.00	0.00	.01	7904.00	2.63
4 TOW PRAC	0.00	0.00	4.24	58.12	67.02	0.00	6.50	0.00	.01	7904.00	2.14
7 TOW PRAC	0.00	0.00	4.24	58.12	67.02	0.00	7.00	0.00	.01	7904.00	2.30
9 TOW PRAC	0.00	0.00	5.40	65.56	67.02	0.00	5.50	0.00	.01	7904.00	1.81
10 TOW PRAC	0.00	0.00	4.24	58.12	67.02	0.00	6.00	0.00	.01	7904.00	1.97
TASKINGS	0.00	0.00	969.73	22794.48	2766.08	0.00	5.00	0.00	5.00	0.00	1.65

Figure 7

AVIATION UNIT FIELD TNG TO INCLUDE SUPPORT OF FIELD TNG

4TH INFANTRY DIVISION
FORT CARSON, COLORADO

(VARIABLE COSTS)

PAGE 3

TY	NAME	TOTAL FIXCST	2620 VARAVGAS GAL	2620 VARAVGAS $$$	264M VARMOGAS GAL	264M VARMOGAS $$$	264D VARDIESEL GAL	264D VARDIESEL $$$	261X VSPARES	2670 VAVSPRS	2600 VAROTH	VAR VAR FHRS
5	4-40 ARMOR	278575	0	0	7563	3252	119794	46720	669400	0	0	0
6	1-12 INF MECH	426421	0	0	13104	5635	47786	18636	162700	0	0	0
6	1-10 INF MECH	426430	0	0	8537	3671	66008	26055	186489	0	0	0
6	1-8 INF MECH	426006	0	0	11956	5141	66008	26055	200839	0	0	0
6	1-22 INF MECH	427103	0	0	7590	3264	41020	15998	123405	0	0	0
5	1-77 ARMOR	270450	0	0	2678	1151	71596	27922	424000	0	0	0
6	1-11 INF MECH	426265	0	0	17296	7437	71865	28027	245312	0	0	0
5	2-34 ARMOR	270852	0	0	2043	879	69849	27241	553770	0	0	0
5	6-32 ARMOR	279174	0	0	2770	1191	33004	12872	186771	0	0	0
7	1-19 FA,155SP	265607	0	0	5711	2456	21941	8557	57179	0	0	0
7	1-20 FA,155SP	265522	0	0	7930	3410	27897	10880	77428	0	0	0
7	1-29 FA,155SP	265609	0	0	6335	2724	20757	8095	57914	0	0	0
7	BTRY H,(TAB),29	78489	0	0	20723	8911	11138	4344	21092	0	0	0
7	1-27 FA,8 IN	250051	0	0	5241	2254	8759	3416	34376	0	0	0
10	4-61 ADA	295665	0	0	6142	2641	52750	20573	278112	0	15700	0
8	1-10 CAV	581524	179909	88195	7241	3114	42253	16479	370023	143051	0	3213
17	4TH AVIATION CO	270021	107904	52873	2117	910	4475	1745	12771	105255	0	3025
15	4TH ENGINEERS	492230	0	0	6187	2661	211958	82664	402286	0	126915	0
16	124 SIGNAL BN	315246	0	0	28845	12404	62657	24436	215111	0	0	0
21	4TH MP CO	96692	0	0	19814	8520	1729	675	25127	0	0	0
21	4TH MI CO	44361	0	0	785	337	1142	445	1223	0	0	0
21	HHC 1 ST BDE	58676	0	0	0	0	0	0	0	0	0	0
21	HHC 2 ND BDE	50035	0	0	0	0	0	0	0	0	0	0
21	HHC 3 RD BDE	50559	0	0	0	0	0	0	0	0	0	0
21	HHB DIVARTY	125194	0	0	0	0	0	0	0	0	0	0
21	DISCOM	1616712	0	0	0	0	0	0	0	0	0	0
21	984 M P CO	90061	0	0	0	0	0	0	0	0	0	0
21	179 AVIATION CO	325359	0	0	0	0	0	0	0	0	0	0
21	HHC 4 TH DIV	104557	0	0	0	0	0	0	0	0	0	0
21	43 RD SPT GRP	1026182	0	0	0	0	0	0	0	0	0	0
TOTAL PROGRAM												
TOTAL P2 GUIDANCE		9934830	287893	141068	190600	81962	1055986	411835	4307007	248306	142615	6238
UNPROGRAMMED		10410723	287893	141068	190608	81962	1055986	411835	4307007	248306	142615	6238
		475893										

ESTIMATED REQUIREMENT

REPRICED TO INCL DIV LEVEL MAINT.

- BATTALION MODEL PRICED SOLUTIONS
- TRUE COST OF FIELD TRAINING ...

Figure 8

TY	NAME	VAR BFTD	VAR ACRE/DAYS	TOTAL VAR$	TOTAL VAR+FIX
5	4-40 ARMOR	100	139061	719452	998027
6	1-12 INF MECH	168	670015	186971	613392
6	1-10 INF MECH	152	532779	216215	642645
6	1-8 INF MECH	152	532779	232035	658841
6	1-22 INF MECH	61	1900446	142667	569769
5	1-77 ARMOR	60	429780	453874	732324
6	1-11 INF MECH	94	1092975	280777	707042
5	2-34 ARMOR	82	179816	581890	860743
5	6-32 ARMOR	59	14079	200833	480007
7	1-19 FA,155SP	34	209950	68191	333799
7	1-20 FA,155SP	50	747916	91718	357239
7	1-29 FA,155SP	67	293930	68733	334342
7	BTRY H,(TAB),27	38	0	34347	112835
7	1-27 FA,8 IN	35	188708	55746	306597
10	4-61 ADA	76	274417	301325	596991
8	1-10 CAV	65	983060	621662	1203185
17	4TH AVIATION CO	8	523640	173554	444375
15	4TH ENGINEERS	190	375193	614525	1106756
16	124 SIGNAL BN	122	33345	251950	567196
21	4TH MP CO	26	49400	34322	131013
21	4TH MI CO	4	37297	2006	46367
21	HHC 1 ST BDE	0	0	0	58676
21	HHC 2 ND BDE	0	0	0	58835
21	HHC 3 RD BDE	0	0	0	58559
21	HHB DIVARTY	0	0	0	125194
21	DISCOM	0	0	0	1616712
21	704 M P CO	0	0	0	90061
21	179 AVIATION CO	0	0	0	325359
21	HHC 4 TH DIV	0	0	0	104557
21	43 RD SPT GRP	0	0	0	1026102
	TOTAL PROGRAM	1639	9296586	5332791	15267621
	TOTAL P2 GUIDANCE	1639	9296586	5332791	15743515
	UNPROGRAMMED	0	0	0	475893

Figure 8 (continued)

The TMCS was tested in the 4th Infantry Division (Mechanized) at Ft. Carson, Colorado in the fall of 1977 and proved successful. Additional testing is planned in an effort to validate the equipment operating cost factors and the garrison cost estimating techniques. While it is not certain when this system will be available Army-wide, the advantages of the system seem clear. The commander will, at last, have quantifiable requirements to present in support of requested funding rather than his subjective analysis of the resources required and impact of various funding levels on his training plan.

It would appear, however, that the TMCS may have applications beyond those recognized at this time. Specifically, the TMCS may be of value in estimating training costs associated with new weapon systems. That is, during the development phase of the acquisition process, after the CTEA has been conducted and the operating cost factors have been determined for the new item of equipment, and after a doctrine for employment has been developed, estimates of additional training events required can be entered into TMCS and a new cost arrived at for annual training of battalions receiving the new equipment. Normally this new figure will be higher than the battalion's previous training cost estimate, and this incremental difference is attributable to the costs incurred in becoming combat ready

with this new equipment. This figure can then be multiplied by the number of battalions Army-wide that will receive this equipment, and the resulting figure added to the life cycle cost estimate. When the equipment in question is issued to all infantry battalions, for example, the figure can be quite substantial for a 16 division force. This cost difference should be recognized as a non-recurring cost in that once a unit has achieved the desired readiness level with a piece of equipment, the costs associated with maintaining that level should be less, and in fact approach a constant figure for the ensuing years. If, however, this constant level is higher than the previous weapon system required, then the incremental recurring cost should also be included in the life cycle cost.

The adoption of this system would provide the Division Commander with a sound cost estimate for the training funds required in the year in which he is to receive the new equipment. Presently he must operate with funds based on current unit configuration, and training costs associated with new equipment must be absorbed within the existing OMA budget. Recognizing that a degradation of readiness is unacceptable, funding realities therefore dictate that cuts in other areas be made due to these unprogrammed training exigencies. Improved cost estimating and corresponding budgeting will enable unit commanders to avoid

this method of operating. The additional BFTDs generated by new equipment will be calculated by TMCS and provide justification for increased funding. It will be a fairly simple task to show the amount of training that can be accomplished with given funding levels for the new weapon system. That is, the training cost to achieve a given readiness level, i.e. to successfully complete an ARTEP, will be readily identifiable. While there is subjectivity involved in arriving at the number of additional BFTDs required to achieve a desired readiness level with a new weapon system, the initial estimate can be refined through results obtained from the operational tests conducted during the development phase. As the weapon system is issued to operational units and data on training results become available the training estimate can be further updated.

By definition, BFTDs communicate time requirements associated with training events necessary for achieving a given level of unit readiness. For battalions of a given type (Armor, Mechanized Infantry, Field Artillery, etc.) and with the same training readiness mission, the requirements in terms of BFTDs would be relatively the same. Therefore, an Army-wide composite BFTD requirement could be developed for the new weapon system by taking a weighted average of the BFTD requirements of the different groups of battalions.

This technique, however, does not address dollar resources which are the primary concern of OSD and Congress. Therefore, to be a useful tool for relating the unit training readiness requirements to dollars, BFTDs must be convertible to dollar requirements.

The cost of unit training is dependent on the type of training event undertaken more than the time required to perform it. This is clear from Figure 8, where one finds the variable cost of training for the 1/10th Mechanized Infantry battalion to be $216,215 for 152 BFTDs, or about $1422 per BFTD. Meanwhile, the 1/11th Mechanized Infantry battalion is spending $280,777 for 94 BFTDs or approximately $2987 per BFTD. In that these units are exactly the same in terms of configuration and readiness requirements, the large cost difference must be attributable to the type of exercises being conducted. Clearly, a mechanized attack requires more fuel than does a static defense. At battalion level and lower there is little relationship between BFTDs and costs. For example, a training event may require 0.2 BFTD and cost $1000, while another training event may require 1.0 BFTD and cost only $400. A methodology for dealing with this is to express each training event based on its cost as a multiple of a baseline BFTD cost. That is, the baseline BFTD cost would be the average cost of BFTDs required to conduct training

on a battalion-wide basis. For example, if the baseline cost for a mechanized infantry BFTD were $1000, a platoon event costing $300 would equate to 0.3 BFTD, regardless of the time involved. The battalion's total additional training requirement would be the sum of all individual events expressed in baseline BFTDs of $1000 per day.

The cost of a BFTD would be type battalion dependent. That is, an armor BFTD would be more costly than an infantry BFTD. From Figure 8 one finds the 2/34th Armor battalion spending $581,890 for 82 BFTDs, or $7096 per BFTD. This is nearly five times the cost per BFTD for the 1/10th Mechanized Infantry. However, an Army-wide BFTD cost could be computed, once again, by taking a weighted average of the BFTD costs for the various battalion types receiving the new weapon system.

Using the data from Fort Carson at Figure 8, an example will serve to highlight the order of magnitude of the costs involved. Assume a new weapon system has been received, and it has been determined that 14 BFTDs are required for a unit to return to its previous readiness level after receipt of the weapon. Further, assume that the weapon system is issued to all infantry and armor battalions. From Figure 8 one finds that the average cost of a mechanized infantry BFTD is $1688, and an armor BFTD costs $6498. With five mechanized infantry and four armor

battalions, the cost of these 14 BFTDs is $482,048. That is, the Division Commander is faced with nearly one-half million dollars in training costs merely because he received the new weapon system. All he can purchase with that money is a return to his previous readiness level.

To restate, the current system provides no means by which the additional training resources for the introduction of a new weapon system and its concomitant effect on readiness can be recognized. To overcome this deficiency there must be a single point within the Army force structure, i.e. FORSCOM, which can control both the rate at which new weapon systems are introduced and also provide, through proper budgeting, the recognition of additional training resource requirements for those new systems.

The methodologies discussed in this section provide for two levels of aggregation. The first permits unit commanders to prepare improved budgets for unit training and thus avoid having to make difficult trade-off decisions when unanticipated training requirements associated with new weapon systems appear. The second affords the Army the ability to quantify unit training requirements and to relate those dollar requirements directly to training readiness.

V. THE TOW WEAPON SYSTEM AND THE 7TH INFANTRY DIVISION

A. INTRODUCTION

The use of the TOW as an example did not involve a careful analysis by the authors of the many weapon systems currently in the arsenal. The TOW was selected because the nearest Army division, the 7th Infantry Division at Ft. Ord, California, was in the process of receiving its initial issue of the TOW during the research phase of this paper, and thereby provided a convenient case in point.

It is a particularly good weapon system for an analysis of unit training costs. Indeed, the TOW was used to a limited degree in Viet Nam, and has been in the hands of troops in Western Europe for nearly ten years. CONUS divisions have received the TOW in the last five years, and the 7th Division, the 5th Division at Ft. Polk, Louisiana, and the 24th Division at Ft. Stewart, Georgia all were formed in 1974 and have been receiving the weapon system during the past three years. It is apparent, then, that the Army does have considerable experience in issuing the TOW to combat divisions and for that reason it is an interesting example of the Army's progress and implementation of lessons learned during that period. While one would expect that problems encountered in training and funding associated with that training would have been documentated and disseminated to units anticipating receipt of the weapon system, apparently such is not the case.

B. THE 7TH INFANTRY DIVISION

Formed in 1974, the 7th Infantry Division consists of two active duty infantry brigades and a "round out" brigade of the Oregon National Guard. It is one of only two light infantry divisions in the active Army, the other being the 9th Infantry Division at Ft. Lewis, Washington. With the activation of three new divisions in the same time frame (5th, 7th, 24th), a shortfall in weapon systems available for issue to these divisions resulted. Indeed, not all of the 13 divisions on the Army's rolls in 1974 had received the TOW. Accordingly, the 7th Division was initially equipped with the 106mm recoilless rifle as its heavy anti-tank weapon. Trained crewmen for that weapon were readily available in that it has been in the inventory for many years, and a separate MOS existed for it thereby relieving the units from individual training requirements. Consequently, anti-tank platoons were formed, and battalion tactics were based on having an anti-tank weapon system with a maximum effective range of 1100 meters. Battalion commanders then set about the arduous task of molding a combat ready force. It should be noted here that the table of organization and equipment the 7th Division was operating under provided for no 106mm recoilless rifle in the companies, all such weapons were in the battalion's anti-tank platoon located in the Combat Support Company.

They were essentially the battalion commander's anti-tank weapons, employed by him based on recommendations from the anti-tank platoon leader and the Combat Support Company commander.

Collocated with the 7th Division at Fort Ord is the Combat Developments Experimentation Command (CDEC). This organization conducts experiments for the Army concerning weapon systems, tactics, doctrine, etc. In June, 1976 CDEC was conducting tests with the TOW, and inquired of the 7th Division as to the desirability of their providing troops in support of the test. The 7th recognized the opportunity to gain TOW experience for a few troops and provided two 26-man anti-tank platoons to CDEC for the testing. At the time the 7th Division knew they would be receiving the TOW but did not know specifically the time frame in which they would arrive. Accordingly, the two platoons received two weeks of training on the TOW, essentially at no cost to the 7th Division in that all support was provided by CDEC. As events developed, the first increment of TOWs did not arrive until January, 1977, and with the 7th Division experiencing a personnel turnover rate of approximately 20%, only about 40 of the individuals that received this training were still in the division when the initial TOWs arrived.

In November, 1976, having been notified that the first TOW shipment would arrive in January, the 7th Division sent 30 individuals to Fort Benning, Georgis for three weeks to receive instruction on the TOW. This group consisted primarily of noncommissioned officers from anti-tank platoons throughout the division. This was to be the nucleus of trained instructors who would provide TOW instruction in the division. The cost to the 7th Division associated with sending this contingent to Ft. Benning for three weeks was $14,451.[21] With six infantry battalions in the division, this training provided only five school-trained TOW crewmen per battalion.

In January, 1977 the 7th Division received its first increment of 36 TOWS. This enabled them to fully equip two battalions. At the same time the Division TOW school was established. It was conducted at Brigade level and required seven military instructors and two civilians to operate. The school was of one week's duration and consisted primarily of instruction on the TOW's capabilities, operation, and maintenance. The 40 hour course included two hours of instruction on enemy armor identification and tactics, and one-half hour on preparation of range cards, a diagram of the defensive sector prepared by each fighting position. These two blocks were the only ones in which tactics were even obliquely discussed. No instruction was

presented by the school concerning the doctrine for employing the TOW in the various tactical maneuvers. Such instruction was, presumably, left in the hands of the unit. In that the introduction of the TOW required a reorganization within each battalion (TOWs became organic to each rifle company whereas the 106RR was not), and required a significant revision in tactics, it is unfortunate that the TOW crews did not receive more instruction of a tactical nature. Perhaps the reason is that until battalions and their commanders had an opportunity to experiment with various methods of employment in a field environment, the employment principles were uncertain. Indeed, doctrine for a light infantry division facing an armor threat is tenuous at best.

In the unit one finds the non-commissioned officers that attended the school at Ft. Benning providing the instruction. While they were knowledgeable concerning the employment of the TOW itself in a given tactical role, their experience and schooling does not provide them with an over-view of how the TOW interacts with the other weapon systems in the battalion and its impact on the overall doctrine for employment of the battalion. Indeed, such knowledge should reside with the officers in the battalion, the battalion commander and company commanders. The battalion commander, typically, is a graduate of the Command and General Staff College, where discussion is on a somewhat grander scale

than the tactical employment of an infantry battalion. The company commanders may be graduates of the Infantry Officer's Advanced Course, in which case they will have been exposed to the doctrine of TOW employment. Experience has shown, however, that at least one, and maybe more, of the company commanders have not attended the Advanced Course prior to assuming command. Accordingly, a need exists for doctrinal instruction on employment for the officers. Given the experience with TOW present in the Army in 1977, it would appear that a training team (perhaps only one or two TOW-experienced officers) could have been made available to present instruction on employment tactics and techniques to the officers of the 7th Division. The problem in the 7th Division was somewhat compounded in that the training materials published by TRADOC discuss TOW employment by mechanized and armor units. No manual existed for TOW employment by light infantry units such as the 7th Division.

A battalion is faced, then, with returning to its previous level of combat readiness armed with this new weapon. The only way to accomplish this is to conduct field training exercises and determine what problems are encountered in employing the TOW in various offensive, defensive, and retrograde maneuvers. Such problems as site selection, command and control, general or direct support roles, cover and concealment, determining kill zones, fire

control, logistics support, and many others all need to be addressed by the battalion and a determination made as to the standard operating procedures (SOP) that can be developed to solve these problems. Many problems do not lend themselves to being resolved by SOP, but must be addressed in situational environments. These types of problems must be identified and discussed so that the company commanders are made aware of the tactical philosophy of the battalion commander and their expected responses to problems of this nature. Overlying all of these particular details of employment is the larger question of the impact that the TOW has on the employment of the remainder of the battalion. That is, the increased range available to the commander requires a re-evaluation of the tactical principles with which he is familiar. For example, a major mission of rifle platoons now becomes one of protecting the TOWs. The survivability of a light infantry battalion facing an armor threat depends, to a large degree, on the survival of the TOWs. Therefore the commander must use maneuver elements to provide security for those weapons, a nontraditional role for infantry maneuver elements.

C. A BATTALION EXAMPLE

That was the problem facing the 3d Battalion, 17th Infantry on 6 December 1977 when they received their TOW weapon systems. The 3/17 Infantry was one of the last two

battalions in the 7th Division to receive the TOW. On 6 December the Anti-Tank Platoon of the 3/17th Infantry had no TOW trained personnel assigned to it, nor did any of the TOW sections in the rifle companies. The Anti-Tank Plantoon did have three non-commissioned officers assigned who had served in Europe and had therefore gained experience on the job with the TOW. In January, 1978 the battalion received a quota for the TOW school at Ft. Benning and sent their Anti-Tank Platoon leader. During January they received four personnel from Advanced Individual Training who had received TOW gunner training. Therefore, upon deployment to Ft. Irwin, California for a three week field training exercise, the battalion had 8 individuals with TOW training/experience of the 74 assigned to TOW positions. There are 78 total TOW positions authorized in the battalion. Only one of the company commanders was a graduate of the Advanced Course.

Upon the Battalion's return from Ft. Irwin, the authors interviewed the Battalion Commander[22]. The role of the 3/17th Infantry in the FTX had been purely in a static defense. Accordingly, the gunners received valuable tracking experience, but the battalion had no opportunity to maneuver. Additionally, the FTX was conducted on a Brigade level, and the battalion was therefore somewhat constrained in the type of training conducted. When asked how long, under then

foreseeable conditions, it would be until the 3/17th Infantry would return to a combat ready status equipped with the TOWs, the Battalion Commander replied, three months. That would bring the total elapsed time from receipt of the weapon system to a combat ready status of approximately 5 1/2 months.

The authors then asked the Battalion Commander to estimate the time required to reach a combat ready status if the battalion could deploy to the field and have no distractions from the training tasks. His reply at this point was four weeks. He was then asked to estimate the time required under the same conditions if the battalion had kept the 106RR as its heavy anti-tank weapon. His reply was two weeks. Incrementally, then, there is a 14 day period of intensive training required for the battalion caused by the introduction of the TOW. It should be noted that the battalion commander had served in a sister battalion as both the operations officer and executive officer immediately prior to assuming command of the 3/17th Infantry. Having had these varied perspectives, his estimate is as valid as any that could be arrived at. Costing this estimate with average figures generated by the TMCS for the Ft. Carson test, one finds a transition cost of approximately $26,275 for this battalion. In that the 3/17th Infantry is probably typical, this represents a cost

to the Division of $236,475 for the nine battalions receiving the TOW (three of which are National Guard battalions). In that the O&M budget for the 7th Division was approximately $18 million in FY77, this represents 1.3% of its total mission funding! Extrapolation of this data for a 16 division Army leads to transition costs of over $3.7 million, or 1.8% of all operating funds spent in support of the TOW from FY70 to FY77.

It is important to remember that none of the costs discussed in this chapter were anticipated, indeed most were not even recognized. While several of the problems identified in the 7th Division were not directly associated with funding, a recognition of the problems experienced in returning a unit to a combat ready status after deployment of a new weapon system is the first step in solving many of them.

VI. CONCLUSIONS AND EXTENSIONS

What has been presented to this point is an examination of the current system for determining costs of a new weapon system, a revelation of the cost of re-establishing readiness levels for a unit subsequently equipped with that system, and a possible means to incorporate this estimated cost into the decision-making process so that it may be considered prior to committing the Army to procurement and deployment of the weapon system.

As examined in the first chapter, the Army today is continuing to place great emphasis on training and its relationship to readiness. That is not surprising, in that the Congress funds the Army for training which must be converted to a measure of readiness in some manner. The current economic environment dictates a policy of achieving a combat level of readiness subject to a given budget, or stated another way, maximum training effectiveness subject to a budget constraint. To resolve this problem close scrutiny of training effectiveness relative to combat effectiveness is being conducted by study groups within the Army.

The authors conclude that the current life cycle cost model does not make provision for a cost element which recognizes the costs of unit training. This omission is more significant in view of current events which place greater emphasis and reliance on individual training conducted by the units of the Army as opposed to the institutional training of individuals prior to their arrival in the units. The absence of a cost element in the LCC model precludes budget recognition of such costs by FORSCOM. Commanders receiving new weapon systems are not alerted to the increased costs generated by receipt of those systems, and therefore find themselves confronted with funding trade-offs.

As discussed in Chapters 3 and 4, no direct cost estimating relationships have been developed by the Army for combat effectiveness due to an inability to measure output at the present time. To overcome this obstacle in developing cost estimates of training, an indirect relationship must be established. The authors recommend using battalion field training days as a proxy variable for combat effectiveness and development of an indirect cost estimating relationship by that means. By so doing, analysis of resource use and budget constraints may then proceed on an orderly basis.

To illustrate the logic of developing a cost estimating relationship for training refer to Figure 9. The matrix shows four categories of costs which must be addressed. Each category will have different factors which will produce the most significant cost change. The form of the relationships are thought to be such that:

I. Direct Recurring Cost = f(# of units receiving the weapon system, # of personnel per system requiring unit training, time required to qualify, turnover rate of qualified personnel). Exactly what mathematical relationship exists cannot be identified due to the diverse nature of weapon systems.

II. Direct Non-Recurring Costs = f(# of acres of land required for training on the system in excess of existing land, instructor training, # of new training

	RECURRING	NON-RECURRING
DIRECT	I	II
INDIRECT	III	IV

Figure 9

support equipments necessary to support training at each installation, i.e. targets, range facilities).

III. Indirect Recurring Costs = f(new tactics required for employment of the weapon system which would be taught to all personnel in a unit, personnel turnover, other significant changes which occur periodically).

IV. Indirect Non-Recurring Costs = f(new tactics as they require one-time training for the entire unit, special weapon system characteristics which require one-time adjustment of support elements).

The above example is not extended to be an exhaustive treatment of the training costs associated with re-establishing readiness levels for a unit. It is merely intended to protray how the segments of training costs; recurring vs. non-recurring and indirect vs. direct; are driven by weapon system characteristics and how complex the inter-dependencies of these characteristics and costs can become. For that reason the Army's life cycle cost model fails to provide complete cost estimating. Another point which can be made is that life cycle costing may not recognize these training costs because the various personnel policies are established at a higher level. The reality is that these policies must be considered and analyzed in completing a training analysis as the ability to have an effect on

retention and for recruitment will also have an effect on the cost of training. The authors maintain that the complexities present in training analysis preclude accurate cost estimating for training and that the use of the proxy variable BFTD will yield better information since it is a recognition of these costs. It is not considered to be the answer to all the problems but a movement to establish credibility in training costs and budget development.

The use of BFTDs as a proxy measure of combat effectiveness also allows the use of an existing information and accounting system, the TMCS. By using this system early in the analysis process for a new weapon system, the opportunity is provided for field level evaluation of a developing system. That is, field experience in costing training will be used directly to measure the ease of training for a conceptual system. This would appear to achieve a signal impact on the development of training systems for a new weapon system which are at least as effective in the use of resources as the training system for the old weapon system. By achieving this objective, the Army will have improved on gaining the highest level of training possible given the existing budgetary constraints.

GLOSSARY

ARTEP - Army Training and Evaluation Program

BFTD - Battalion Field Training Day

CATTS - Combined Arms Tactical Training Simulator

COEA - Cost and Operational Effectiveness Analysis

CTEA - Cost and Training Effectiveness Analysis

FTX - Field Training Exercise

FORSCOM - U.S. Army Forces Command

LCC - Life Cycle Cost

MILES - Multiple Integrated Laser Engagement System

MOS - Military Occupational Specialty

MOTE - Measure of Training Effectiveness

MTBF - Mean Time Between Failure

REALTRAIN - Realistic Training

SCOPES - Squad Combat Operation Exercise, Simulation

SOP - Standard Operating Procedure

SUE- Small Unit Evaluation

TAC - Training Analysis for COEA

TDS - Training Development Study

TMCS - Training Management Control System

TOW - Tube launched, optically tracked, wire command-link guided missile system

TRADOC - U.S. Army Training and Doctrine Command

TRASANA - TRADOC Systems Analysis Agency

TUS - Train-up Study

FOOTNOTES

1. Logistics Management Advisory Committee, Life Cycle Cost - Findings and Recommendations, report prepared for the Assistant Secretary of Defense (I&L) by an NSIA "Ad Hoc" Committee, April 1976, pg. 5.

2. United States Department of Defense Instruction 7041.3, Economic Analysis and Program Evaluation for Resource Management, 1972, pg. 2.

3. Joint Tactical Communications Office, Cost Effectiveness Program Plan for Joint Tactical Communications, Vol. III, Ft. Monmouth, N.J., June 1976, pg. 3.

4. Gene H. Fisher, Cost Considerations in Systems Analysis, Rand Corporation, 1970, pg. 68.

5. United States Department of the Army Regulation 11-18, The Cost Analysis Program, 1975, pg. 2-1.

6. Fisher, loc. cit., pg. 41,66.

7. Headquarters, United States Army Training and Doctrine Command Pamphlet 71-10 (Draft), Cost and Training Effectiveness Analysis Handbook, 3 January 1977, pg. 3.

8. Hogan M. Wilson, Major, USA, Training Planning in the Acquisition Process Must Keep Pace with Changing Training Trends, paper prepared for Program Management Course, Defense Systems Management College, November 1976, pg. 15.

9. Ibid.

10. Human Resources Research Organization Technical Report # 77-1, Team Training and Evaluation Strategies: State-of-the-Art, by H. Wagner, N. Hibbits, R.D. Rosenblatt, and R. Schulz, February 1977, pg. 7.

11. Ibid.

12. Headquarters, United States Army Training and Doctrine Command Pamphlet 71-10 (Draft), pg. 11.

13. Ibid., pg. 87.

14. Human Resources Research Organization Technical Report # 77-1, pg. 26.

15. Ibid., pg. 30.

16. United States Army Infantry School Development Report No. 3, "TOW System Evaluation", by Directorate of Evaluation, December 1976, pg. 2.

17. _Ibid._, pg. 36.

18. _Ibid._, pg. 62.

19. _Ibid._, pg. 69.

20. Lilje, Colonel, USA, _Training Management Control System (TMCS)_, point paper prepared at Headquarters, United States Army Forces Command, 26 August 1977, pg. 1.

21. Interview with CPT Lowery, office of the G-3, 7th Infantry Division, on 18 November 1977 at Ft. Ord, California.

22. Interview with LTC Sterling Bassett, Commander, 3d, Bn, 17th Infantry on 27 February 1978 at Ft. Ord, California.

BIBLIOGRAPHY

Caver, Troy V., Major, USA, Training Developments: A Means to Reduce Life Cycle Costs?, paper prepared for Program Management Course, Defense Systems Management College, May 1977.

Defense Logistics Studies Information Exchange, Summary Report of the Task Force on Training Technology, January 1977.

Fisher, Gene H., Cost Considerations in Systems Analysis, Rand Corporation, 1970.

Human Resources Research Organization Technical Report # 77-1, Team Training and Evaluation Strategies: State-of-the-Art, by H. Wagner, N. Hibbits, R.D. Rosenblatt, and R. Schulz, February 1977.

Headquarters, United States Army Training and Doctrine Connand Pamphlet 71-10 (Draft), Cost and Training Effectiveness Analysis Handbook, 3 January 1977.

Lilje, Colonel, USA, Training Management Control System (TMCS) (Formerly P2 Mission Model), point paper prepared at Headquarters, United States Army Forces Command, 26 August 1977.

Lilje, Colonel, USA, Update, Training Management Control System (TMCS), fact sheet prepared at Headquarters, United States Army Forces Command, 25 January 1978.

Litton Mellonics System Development Division report, Implications for TOW Gunnery Training Development, by R. W. Swezey, T.E. Chitwood, Jr., D.L. Easley, and B.J. Waite, 21 October 1977.

Logistics Management Advisory Committee, Life Cycle Cost - Findings and Recommendations, report prepared for the Assistant Secretary of Defense (I&L) by an NSIA "Ad Hoc" Committee, April 1976.

United States Army Infantry School Development Report No. 3, "TOW System Evaluation", by Directorate of Evaluation, December 1976.

United States Department of the Army Pamphlet 11-3, Investment Cost Guide for Army Material Systems, 1976.

United States Department of the Army Pamphlet 11-4, Operating and Support Cost Guide for Army Material Systems, 1976.

United States Department of the Army Pamphlet 11-2, Research and Development Cost Guide for Army Material Systems, 1976.

United States Department of the Army Regulation 11-18, The Cost Analysis Program, 1975.

United States Department of Defense Instruction 7041.3, Economic Analysis and Program Evaluation for Resources Management, 1972.

Wilson, Hogan M., Major, USA, Training Planning in the Acquisition Process Must Keep Pace with Changing Training Trends, paper prepared for Program Management Course, Defense Systems Management College, November 1976.

Interview with CPT Lowery, Office of the G3, 7th Infantry Division, on 18 November 1977 at Fort Ord, California.

Interview with LTC Sterling Bassett, Commander, 3d Bn, 17th Infantry on 27 February 1978 at Fort Ord, California.

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